The importance of the Deutsche Luxfer Prismen Syndikat, the Victoria regia lily and Gothic imitation in the design of Bruno Taut's Glashaus

Neal David Nielsen

N.Dip. Arch. Tech, N.H.Dip. Arch. Tech, B.Tech. Arch. Design, M.Tech. Arch. Design, B.Arch.

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Abstract

Bruno Taut's *Glashaus* at the *Werkbund* Exhibition of 1914 is considered a seminal example of early modernist architecture; hence it is included in all its official histories. Yet, some of the crucial factors behind the design of the *Glashaus* remain little understood. In an attempt to address this situation, this PhD reveals that the *Glashaus* was the result of a strong architect-client interaction. In fact, Frederick Keppler, the *Glashaus'* patron and director of the *Deutsche Luxfer Prismen Syndikat*, had a significant influence on its design. He wanted his company's Luxfer prototype, which had been developed over many years at earlier exhibitions, to be the major material constituent of the building. In order to show the glazed products of Luxfer in the best manner possible, Keppler insisted on a design featuring a glazed dome, electric lighting, a fountain as well as a cascade. Taut, as the architect, had to formulate a design that met these detailed stipulations. For the *Glashaus*, Taut turned to myths and symbols associated with the *Victoria regia* lily and the Gothic in order to provide his interpretation of the brief. By clarifying the background behind this architect-client relationship and these other under-examined sources, this PhD will significantly expand the understanding of the *Glashaus,* particularly as a collaborative endeavour, and thus reinvigorate our comprehension of one of the most distinctive early examples of modern architecture.

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Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, this thesis contains no material previously published by the author that is outside the direct scope of this research project. Neither does it contain material written by another person except where due reference is made.

QUT Verified Signature

Signature: ___________________________

Date: 12 February 2015

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Chapter 1: Introduction

Why should anybody care about Bruno Taut's *Glashaus*? After all, it was only a small exhibition building at a relatively obscure exhibition, which existed as a physical object for a few short weeks during the summer of 1914. To answer this question, one needs to view the *Glashaus* as a powerful and seductive metaphor. With the story of the *Glashaus,* architectural history has been written, contested and reinvented numerous times. Even at its 100th anniversary, the *Glashaus* still taunts and disturbs architectural history.

Taut's *Glashaus* is often viewed as offering a crucial insight into the thinking behind modernism. Furthermore, critical scrutiny of the *Glashaus* allows one to question the preliminary conclusions of the first histories of the modern movement. Initially, for instance, the *Glashaus* was labelled an Expressionist building. Reyner Banham (1959) later proposed that the history of the modern movement was problematic because of its restrictively linear architectural-stylistic focus. Banham sought to remedy the restrictive analysis of the *Glashaus* by introducing the role played by the bohemian poet Paul Scheerbart in its development. The result was that the understanding of the *Glashaus* was opened up to wider considerations through this literary connection. Thereafter, the *Glashaus* was regarded as both an Expressionist object and a collaborative endeavour between the architect and the poet.

By the end of the 20th century, however, Scheerbart's contribution was being questioned. Both Kurt Junghanns (1983) and Manfred Speidel (1995) showed that Scheerbart's role had been overstated. Subsequently, researchers sought to identify the gap in this collaboration. One particularly interesting contribution was made by Kai Gutschow (2005), who introduced the influential writer and art historian, Adolf Behne, into the *Glashaus* narrative. Gutschow argued that it was Behne who initially propagated the Expressionist interpretation of the *Glashaus*. In response to Gutschow's findings, the collaborative aspects of the *Glashaus* were once again expanded. Behne was added to the list of Bruno Taut and Paul Scheerbart, so that the *Glashaus* became a collaborative endeavour of these three personalities.

There are three significant difficulties, however, with the current understanding of the *Glashaus*. The first problem is that Scheerbart's role, while important at some point, appears to have been subsequently overstated. The second difficulty relates to concerns that the Expressionist label applied to the *Glashaus* is primarily reliant on Behne's association with the project. Third, Taut's own thoughts and motivations appear to have been overlooked in developing this collaborative account of the enterprise. Therefore, perceptions of the *Glashaus* appear to have gone full circle, even to the point of recognising that the understanding of the *Glashaus* may have become too diluted to be effective or clearly understood. The fundamental outcome of this 'broken account' is that certain crucial factors behind the design of the *Glashaus* remain little understood.

Following Banham's initial provocation, all of the authors mentioned above have sought to explain the *Glashaus'* origins in a wider cultural context. Yet, if one takes into account the gradual marginalisation of Taut's own motivations and the influences upon him as the architect of the project, as well as the questions raised over the level of Scheerbart's and Behne's input, the outcome reveals that an architectural historical analysis remains as important and pressing as ever.

This study addresses these limitations in understanding by revealing some crucial motives and inspirations behind the design of the *Glashaus*. These have not yet been fully accounted for in any previous study. This study will therefore contribute to the re-evaluation of the generally accepted histories of the *Glashaus* and, in the process, the modern movement. Yet, this study is not a comprehensive account of the careers of Scheerbart, Behne, or Taut—or even the term Expressionism; numerous authors have already undertaken these studies. Equally, this thesis does not totally dismiss the roles played by Behne and Scheerbart in the *Glashaus.* Instead, this thesis accepts that they played a role, albeit a more limited one than outlined in various prior studies. What this thesis establishes is an alternative account of the original collaboration that informed the *Glashaus* design more directly.

Dietrich Neumann (1995a) first alluded to the relationship between Bruno Taut, as architect, and his client, Frederick Keppler, of the *Deutsche Luxfer Prismen Syndikat* (German Luxfer Prism Syndicate). This is an important aspect of the commission that has not been fully researched. From an architectural perspective, this would seem the logical starting point for an investigation of the *Glashaus'* origins because all architecture has both a commissioning client and a designer to creatively develop the brief. Importantly, the relationship between the two is often filled with varying intentions (and thus tensions) on the path to a final outcome.

In the three chapters following the Literature Review, this thesis will argue that Keppler mandated a prototype building for the design of the *Glashaus*. It will be demonstrated that by 1914, this prototype was *tried and tested* because it derived from similar buildings at earlier exhibitions—in particular the World's Fairs of 1893 and 1900. Given the detailed stipulations of this brief, it will be proposed that Taut's design response for the *Glashaus* was interpretive; that is, it only allowed for the 'artistic clarification' of the requirements of the brief.

This thesis will establish a number of new insights into this well-worn analysis of the *Glashaus*. First of all, Taut's response offered a vivid interpretation of his client's requirement for a building that presented his products in the best possible manner. The requirements were that the building had to be structurally expressive, and that it had to contain a glazed dome, electric lighting, a fountain and a cascade. Second, the thesis establishes that Taut's design drew from earlier architectural precedents in order to fulfil the brief, namely the Gothic. Third, it shows that Taut was also attracted to the design inspiration offered by the *Victoria regia* lily. To satisfy Keppler's brief, Taut subsequently extracted the myths and symbols associated with these two precedents and reworked them in the design of the *Glashaus*.

Using a methodology of interpretive-historical inquiry, this study concludes that the *Glashaus* was the result of a particularly focused client–architect relationship: Keppler, as the client, sought a particular type of building to best display his new building products, while Taut, as the architect, designed a building that was equally firmly based on earlier architectural precedents. This PhD therefore establishes the collaboration pivotal to the *Glashaus* design that has been largely overlooked. In the process, it establishes the previously overlooked importance of the *Victoria regia*, the *Deutsche Luxfer Prismen Syndikat* and the Gothic in Taut's design.

1.1 Hypothesis

The historical understanding of the *Glashaus* is problematic for two reasons: one, it is overly influenced by Adolf Behne's writings, and, two, Paul Scheerbart's role has been overstated.

1.2 Aim

This study aims to establish the diverse motives and inspirations behind the design of the *Glashaus*, which have not yet been fully accounted for in any previous studies.

1.3 Objectives

1. To provide new evidence outlining Bruno Taut's original inspirations and motives for the design of the *Glashaus*;
2. To examine the role played by the client in the design of the *Glashaus*;
3. To modify and extend the historiography of the *Glashaus*.

1.4 Methodology

The methodology employed is qualitative in nature in that it deals with the history of interpretation surrounding Taut's *Glashaus*. This methodology of interpretive-historical inquiry, which is used in this research, involves the researcher collecting as many facts as possible regarding a complex phenomenon, and proposing a plausible account of it. This requires a search for facts, the collecting and organisation of the facts, the subsequent evaluation of the facts, and finally, the construction of a 'narrative' for the evidence that is complete and believable (Groat & Wang, 2002). The validity of this methodology has been established by numerous prior theses, which have investigated the *Glashaus*, Taut and issues pertinent to both (Ersoy, 2008; Gutschow, 2005; Haag Bletter, 1973; Olgren-Leblond, 2008).

John Tosh (2010) identifies a fundamental difficulty with this form of methodology. He argues that historians do not reveal the past; rather they reformulate it through interpretation and in the process the line between fact and fiction may become blurred. An alternative is to consider how the author has used inference or interpretation based on available evidence and facts to ultimately distinguish whether the narrative is fact or fiction (Groat & Wang, 2013). With the *Glashaus* story to date, I assert that the balance between the historical accounts and the available evidence has become distorted due to the over-reliance on the roles of influential people like Paul Scheerbart and Adolf Behne, who have particular investments in certain understandings of the *Glashaus*. This PhD seeks to form a corrective to this drift in the historical account of Taut's construction by evaluating some overlooked evidence that informs its design.

Regardless of the particular merits of any narrative that concerns the *Glashaus*, the fundamental fact remains that we have little choice other than to use an interpretive-historical research methodology that presents the most convincing and coherent narrative available, which is what I seek to do in this PhD. As stated above, this study will therefore adopt this methodology, albeit by attempting to ensure that this narrative is constructed in accordance with the available, existing evidence, which I believe has not yet to date been fully explored.

Robin G. Collingwood proposed that the one of the surest ways to ensure that interpretive-historical narrative does not become fiction was to accept the fundamental importance of the "…one historical world…" (Collingwood, 1956 p.246). This means that the evidence and interpretation of a factual narrative must comply with the continuum of time. If a narrative violates this continuum, it is in all probability drifting away from criteria of history and evidence. Balzun and Graff (2004) proposed that a process of 'verification' is central in ascertaining if a narrative is fictional or factual. 'Verification' therefore entails that historians provide a reasoned and conclusive argument, through the use of numerous examples and evidence, in support of a convincing historical-interpretive narrative.

Nevertheless, Groat and Wang (2002) acknowledged that placing any argument into the all-encompassing 'one historical world' can be a mammoth task (especially so in the case of Taut's *Glashaus*). Therefore, it is appropriate for this dissertation to offer a further qualification in order to ensure a verifiable and convincing narrative.

Tosh (2010) proposed an interesting solution to the difficulties of research generally, and by implication the interpretive-historical research methodology. This involved a ‘cultural turn’ whereby ‘culture’ becomes the focus of research, meaning that a whole range of contextual human behaviours are understood to give rise to the meaning of history and its objects. The ‘cultural turn’ is not just about the content of any given study, but it also explains the theoretical orientation taken by the author. The ‘cultural turn’ does not propose that traditional historical scholarship, based on exhaustive review of literary sources, be abandoned. Rather, it proposes that an inclusive definition of ‘culture’ and the most plausible interpretation of it will be central to any argument.

Considering all of the arguments presented above, it is clear that for this research to produce a convincing and plausible narrative according to an interpretive-historical methodology, this PhD needs to propose logical connections within the ‘one historical world’. A further important step will be an attempt to ‘limit’ the ‘one historical world’ through the use of the ‘cultural turn’. By condensing the ‘cultural turn’ into a specific architectural context, the immense requirements of the ‘one historical world’ become manageable. However, this approach could be seen as directly opposing what the ‘cultural turn’ attempts to correct, i.e., the creation of history by informed elites. This is not the author’s intention. Instead, Taut’s *Glashaus* is considered as an architectural project within a wider context: one with a commissioning client, a brief, and an architect that drew upon historical-architectural precedent to inform his design choices. The direction of this research then becomes clear: it returns the *Glashaus’* client to the explanation and shows how its architect interpreted the client’s brief by analysing its precedents based on the evidence of previously overlooked sources of information. This PhD therefore proposes a different narrative to explain Taut’s *Glashaus* by taking into consideration the brief, the client, as well as outlining numerous examples of precedents and practices associated with horticultural glasshouses, glazed exhibition buildings and Gothic architecture.

While placing the *Glashaus* within these wider, more generic architectural parameters, this PhD research makes one very important contribution to this field of inquiry: it proposes that Frederick Keppler formulated and subsequently outlined a specific client brief for the design of the *Glashaus.*

As part of the process of acquiring evidence and background information for this interpretive-historical research inquiry, the *Werkbund* Archive in Berlin has been consulted. Likewise, numerous visits to buildings relevant to this research have been undertaken. Of the buildings that no longer exist, the author has visited the original locations of the *Glashaus* and the *Victoria regia* glasshouse at the University of Leiden. Likewise, of the buildings that still exist, the author has visited the following: Strasbourg Cathedral; Cologne Cathedral; the glasshouse complex at the Berlin Botanical Gardens, Dahlem; the Alphonse Balat *Victoria regia* glasshouse; Adolf Loos' American Bar, Vienna; the palm house at Schonbrunn Botanical Gardens, Vienna; and the Ny Carlsberg Glyptotek, Copenhagen.

This research analysis returns the understanding of the *Glashaus* to a more quotidian architectural framework in which an architect negotiated with a client, who had a very firm brief in mind. The architect responded with a design informed both by new materials and ideas about architecture, but also through the use of precedent buildings and practices.

1.5 Chapter outline

Chapter 2 comprises the Literature Review. From the many sources available, it became evident that the *Glashaus* can be best explained as the product of a collaborative endeavour between the three key personalities of Bruno Taut, Paul Scheerbart and Adolf Behne. As such, this initial investigation subsequently led to a further study of building precedents, in particular exhibition, Gothic and horticultural glasshouse examples, which had appeared to have relevance to the *Glashaus*. However, the Literature Review also exposed the fact that Taut’s own writings, and thus by implication his thoughts, had strangely been overlooked in most literature concerning the *Glashaus*. Therefore, an attempt was made to provisionally correlate and refine the initial building precedent findings against available literary sources that Taut wrote. The result was that the inspiration for design of the *Glashaus* could be traced to the *Victoria regia* lily; the Luxfer Prism Companies; and particular practices and exemplars that were applicable to Gothic architecture. Thus, Chapters 3, 4 and 5 address each of these three points in detail. It is worth noting that certain portions of Chapters 3, 4 and 5 are exhaustive in their exploration of certain points and examples. This has been done in an effort to satisfy the fundamental requirements of an interpretive-historical inquiry.

Chapter 2: Literature review

2.1 Introduction

Bruno Taut’s *Glashaus* was an extremely influential example of early modern architecture. As such, it is widely discussed in architectural history and extensively referenced (Ching, Jarzombek, & Prakash, 2007; Colquhoun, 2002; Curtis, 1996; Frampton, 2007; James Chakraborty, 2000; B. Richards & Gilbert, 2006; Sharp, 1966; Sharp, Scheerbart, & Taut, 1972; Thiekotter, 1993; Watkin, 2005; Whyte, 1982).

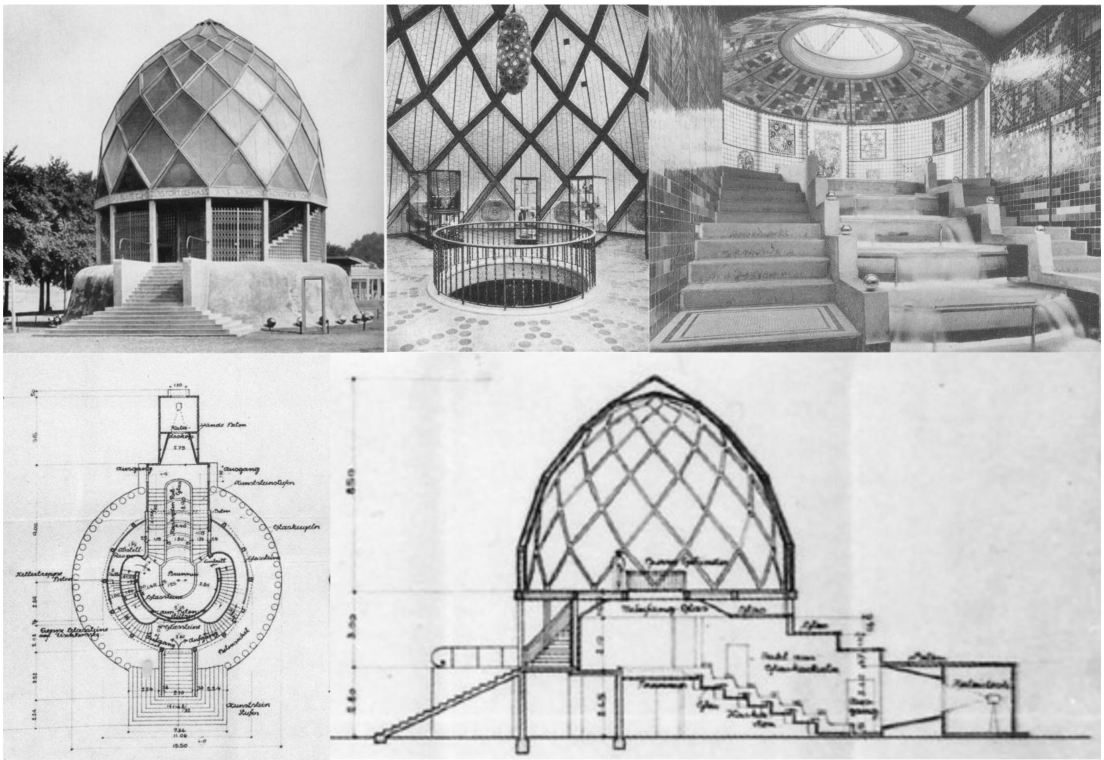


Figure 1 Bruno Taut’s *Glashaus.* Clockwise from top left: exterior; interior of the Dome or Cupola Room; interior of the Cascade Room; longitudinal section; plan of the Cascade Room. (Images: top three -(www.bildindex.de); lower two – (Taut, 1914b).

Open for the duration of the *Werkbund* Exhibition in Cologne, the *Glashaus* was only accessible to the general public from 16 May 1914 to 6 August 1914. Thereafter, access to the *Glashaus* was all but impossible since the site was a restricted military area, both during and after World War One. Stripped of its glass cladding sometime during the course of the war, the *Glashaus’* remaining structural shell was later demolished around 1922 (Held, 1993).

The parameters of debate concerning Taut and the *Glashaus* have been largely established through the writings of Reyner Banham (1959), Dennis Sharp (1966; 1972) and Iain Boyd Whyte (1982; 1985). Constructed for the *Werkbund* Exhibition, the *Glashaus* is generally classified as Expressionist in its style. Although the purpose of the building was to showcase the products of the glass industries, the deeper 'theoretical' intentions of the building encompassed a complex mix of cosmic mysticism and utopian ideals.

In his 1959 article, "The Glass Paradise", Banham was the first English-language author to expose the unique relationship between Taut and the bohemian poet Paul Scheerbart. In doing so, Banham (1959) concluded that the history of the modern movement required rewriting because of its narrow linear perspective and thus its exclusion of an important literary influence like Scheerbart. In 1966, Dennis Sharp accepted Banham's interdisciplinary challenge by documenting the Expressionist origins of modernist architecture in his publication, *Modern Architecture and Expressionism*. In 1973, Rosemarie Haag Bletter published her dissertation, *Bruno Taut and Paul Scheerbart's Vision: Utopian Aspects of German Expressionist Architecture,* in which she systematically explored the Taut–Scheerbart relationship. Haag Bletter further developed her initial argument in a 1981 article, "The Interpretation of the Glass Dream: Expressionist Architecture and the History of the Crystal Metaphor", in which she traced the mystic and historical associations of crystal and glass. In the early 1980s, Iain Boyd Whyte also responded to Banham's call with two publications: *Bruno Taut and the Architecture of Activism* (1982) and *Crystal Chain Letters: Architectural Fantasies by Bruno Taut and His Circle* (1985). As a result of these publications, which formed part of the debate to revise the accepted history of modernism, Scheerbart and Expressionism are now included in most contemporary histories concerning Bruno Taut and the *Glashaus* (Colquhoun, 2002; Curtis, 1996; Hix, 2005; Thiekotter, 1993).

In the 1990s, there was a resurgent interest in Bruno Taut. During this period, numerous additional German publications became available on Taut. These included Angelika Thiekotter's 1993 publication *Kristallisationen, Splitterungen: Bruno Taut's Glashaus (Crystallisation, Splintering: Bruno Taut's Glasshouse)*, and

Leo Ikelaar's 1996 publication *Paul Scheerbart's Briefe von 1913–1914 an Gottfried Heinersdorff, Bruno Taut und Herwarth Walden (Paul Scheerbart's 1913–14 Letters to Gottfried Heinersdorff, Bruno Taut and Herwarth Walden)*. In 2005, Kai Gutschow published his dissertation, *The Culture of Criticism: Adolf Behne and the Development of Modern Architecture in Germany, 1910–1914*, in which he re-established the importance of art critic Adolf Behne's contribution to the *Glashaus.*

Until the 1980s, it was the generally accepted view that the *Glashaus* constituted an Expressionist exhibition pavilion, which resulted from the mutual efforts of Paul Scheerbart and Bruno Taut. However, since the late 1980s, this interpretation has been challenged as highly misleading. In 1995, Manfred Speidel called into question Scheerbart's contribution to the *Glashaus*' design, revealing that Scheerbart only met Taut a few months before its construction – after Taut had finished his preliminary sketches. Kurt Junghanns (1983) had earlier asserted that the *Glashaus* design was complete before Taut and Scheerbart ever met.

Gutschow (2005) proposed that the *Glashaus* was a collaborative result of Taut, Scheerbart and Behne. He argued each of them played a distinct role: Taut was responsible for the overall design of the *Glashaus*, including the circulatory experience, the geometry, the reinforced concrete structure of the dome, the water cascade, and the stained-glass artwork; Scheerbart's role was that of a theorist; and Behne was the official historian of the *Glashaus.* However, Behne's inclusion into the official history of the *Glashaus* was not without significant implications. Gutschow (2005) argued that his inclusion was problematic because he over-emphasised the Expressionist link to the *Glashaus*. As mentioned, Behne was actively seeking to link Expressionism to architecture, a link that did not exist before the *Glashaus*. It was through Behne's involvement with the *Glashaus* that the enduring link with Expressionism was first forged. It was through Behne's prolific writings, and not through Taut, that the *Glashaus* was initially labelled as Expressionist. According to Gutschow (2005), this labelling was particularly troubling considering that nobody contributed more to the original literary record concerning the *Glashaus*, Bruno Taut, and Expressionism than Behne. As such, Behne's original writings could be argued as having unduly influenced the secondary sources of Banham (1959)**,** Sharp (1966) and Whyte (1982; 1985).

Although it is not possible to 'experience' the *Glashaus* anymore, a close interpretation is still feasible due to the existing black-and-white photographs and the technical documentation that was submitted to the Cologne City administration**.** This is despite the fact that Gutschow concluded his reassessment by stating: "Unlike permanent buildings that are more readily reinterpreted by later generations of viewers, Behne's reviews, his panegyrics on Scheerbart, and the few remaining photographs, became the lens through which all subsequent interpretations have been made" (Gutschow, 2005 p.270-1).

Still, it is appropriate to question the current understanding of the *Glashaus***.** Has the historical record not been misled into believing that the *Glashaus* is Expressionist? Furthermore, on the basis of the subsequent research, it is fair to question whether Scheerbart's role has been overstated. While Taut was responsible for the overall design of the *Glashaus,* it was Expressionist art and theory that provided much of the theoretical basis for the design details of the building. Indicative of this tendency, Regine Prange (1991) credited Scheerbart as having been responsible for the 'details' of the glazed floor of the Dome Room, the kaleidoscope, electric lighting and glazed internal partition walls of the *Glashaus*. Speidel (1995) credited Scheerbart as having been responsible for the 'details' of lamp fittings and double-glazing. The Expressionist focus has effectively ignored Taut's central motives, while concentrating on the contributions of Scheerbart and others in the design of the *Glashaus*. This study proposes that an alternative explanation for the origins of the *Glashaus* needs to be formulated that returns to re-examine the sources that influenced the central contribution of Taut.

2.2 Bruno Taut and Paul Scheerbart

Modernism in architecture emerged from the conjuncture of changing possibilities created by different modes of industrialisation, new technical opportunities, and competing modes and conceptions of both modernist and pre-modernist architectural styles and practices. Modernism was particularly prominent in the liberal atmosphere of Weimar Germany. With the rise of fascism in Europe, and particularly Nazism in Germany, a large portion of German modernists emigrated, many eventually settling in the United States of America, where they encountered a vigorous consumerist economy (Weston, 1996)**.** Thus, modern architecture is a term associated with the architecture of this transformational period. It is now generally accepted that modern architecture arose from about the mid-19th century and gained direct inspiration from the new engineering forms of industrialisation – factories, railway stations, exhibition halls, bridges, etc. (Colquhoun, 2002; Curtis, 1996; Frampton, 2007).

Simultaneously, during this period, architects also questioned both the recycling of classical or historic styles (Curtis, 1996; Frampton, 2007) and the eclecticism of previous periods (Colquhoun, 2002). Architects like Walter Gropius, Ludwig Mies van der Rohe and Le Corbusier were at the forefront of the modern movement, as were the collective motivations of the German *Werkbund,* the Bauhaus, the Dutch *De Stijl* and the French *L'Espirit Nouveau* (Ching et al., 2007). Among these pioneering exemplars was the work of the German architect Bruno Taut. The *Glashaus* was the most significant single example of Taut's work that impacted upon early architectural modernism (B. Richards & Gilbert, 2006; Watkin, 2005). Weston (1996) additionally described the *Glashaus* as one of the most remarkable examples of Expressionist architecture. Taut was thus recognised as being at the vanguard of a new generation of German architects on the eve of World War One (James Chakraborty, 2000 p.44).

In "The Glass Paradise", Banham argued for an alternative history of the modern movement, contextualised by one of modernism's favourite materials: glass. Once modernism had reached the United States of America, it had become respectable but timid (Banham, 1959 p.88). Banham argued that by reaching partial maturity in the 1920s and being codified into an international or academic style in the 1930s, the history of modernism had essentially "… cut off half their grandparents without a farthing" (Banham, 1959 p.89). For Banham, the accepted history of modern architecture had a 'respectable ancestry' that was developed in a retrospective linear manner. Banham identified two personalities, Herman

Muthesius and Sigfried Gideon, as key proponents of this linear history (Banham, 1959). In 1902, Muthesius wrote the influential *Stilarchitektur und Baukunst (Style Architecture and Construction)* in which he re-assessed the late-19th century glazed railway stations, covered markets and great exhibition halls, such as Crystal Palace and the *Galérie des Machines* (Gallery of Machines), as architectural objects rather than purely engineering creations. Following his lead, in 1928, Sigfried Gideon published *Bauen in Frankreich (Building in France)*, in which he related the architecture of his generation back to the glazed masterpieces of the 19th century. Banham (1959) also acknowledged the importance of the 1907 work *Eisenbauten: Ihre Geschichte und Aesthetik (Iron Buildings: Their History and Aesthetics)* by Alfred Meyer, as well as the 1923 publication, *Die Ingenieurbauten in Ihre Guten Gestaltung (Engineers' Buildings as Good Design)* by Werner Linder and Georg Steinmetz.

Banham (1959) contended that there was a hitherto-overlooked prophetic ancestry of odd personalities, myths, and symbols. He argued that events in Germany immediately before and after World War One demanded further study. To this end, Banham first proposed two key, but previously overlooked, personalities who emerged from this period that needed to be added to the list of key modernist figures: Paul Scheerbart and Bruno Taut. By linking Scheerbart and Taut to the *Glashaus*, Banham presented an argument that countered the accepted history of the modern movement by introducing a light-mysticism as well as the cultures and practices of the Orient and Gothic Europe, which he believed ultimately, influenced the design of the *Glashaus.* Banham suggested that it would be appropriate to enquire as to the *Glashaus'* origins as the building was both vastly dissimilar from and yet exceeded any of Taut's previous designs (Banham, 1959 p.87). This inquiry into its initial sources goes to the heart of this study: what was the inspiration behind the *Glashaus*' unique design?

Although "The Glass Paradise" first appeared in 1959, it is a valuable resource for any study on the *Glashaus*. Numerous authors have subsequently accepted Banham's argument, and, through their research, uncovered key facts concerning the *Glashaus*.

Dennis Sharp was the first English-speaking author to systematically explore the wider context of Scheerbart, Taut and the *Glashaus*. In his 1966 publication, *Modern Architecture and Expressionism,* Sharp traced the origins of Expressionism to the thinking of the philosophers Friedrich Nietzsche and Sören Kierkegaard within the general context of pre–World War One Europe and particularly that of Germany. Expressionism, according to Sharp (1966), was mainly an artistic melting pot of revolutionary ideas and experimentation. It also applied to everyday life through its attempt to "…re-establish the unity of experience; that of the individual in society" (Sharp, 1966 p.11)**.** As a term, Expressionism was initially associated with painting, but rapidly spread to literature, music and drama, and, later, architecture. Sharp (1966) contended that the best contemporary definition of Expressionism was offered by the *Concise Oxford Dictionary:* Expressionism was an artistic leaning to subordinate realism to the representative or stylistic expression of the artist's or character's own will. Sharp considered architecture to have only played a peripheral role within the wider Expressionist movement. Expressionist architects generally exaggerated and stylised forms (like the painters), developed utopian concepts, and largely emphasised monumentality and symbolism. Sharp clearly emphasised that within architecture, no distinct or defined group or definition of Expressionism ever existed. According to Sharp, the application of the term to architecture is largely a retrospective act by certain critics and historians. Sharp contended that architectural Expressionism had strong links to Art Nouveau. However, he was careful to stress that Expressionism was never a direct evolution. The work of architects such as Victor Horta in Brussels and Antonio Gaudi in Barcelona were regarded as influential. Yet, it was the modernist work of architects likes of Henry van de Velde and Peter Behrens that supposedly made the transition between Art Nouveau's eclecticism and Expressionism's structural rationality, new decorative norms, expressive architectural form and ornamentation (Sharp, 1966 p.21-2).

German Expressionist architecture was deemed to have started in 1908 with the work of Hans Poelzig, and reached a peak at the *Werkbund* Exhibition of 1914. The *Werkbund* was a confederation of German artists, craftsmen and industry, dedicated to the improvement of both society and mass-produced objects through the integration of design, craft and technology (Curtis, 1996).

Sharp (1966) identified three buildings of significance at the 1914 *Werkbund* Exhibition: Henry van de Velde's *Model Theatre*; Walter Gropius and Adolf Meyer's *Model Office and Factory Building*; and Taut's *Glashaus*. All three structures supposedly combined a mixture of the romantic, the objective and the exploratory. Taut's *Glashaus* was viewed as attempting to extend its inner qualities outward through the use of glass, colour and light, which Sharp linked to the influence of Scheerbart. In a later chapter entirely devoted to Taut, Sharp again stressed Scheerbart's influence, even referring to him as Taut's master. According to Sharp, two influential works resulted from the relationship between Taut and Scheerbart: the *Glashaus* and Scheerbart's 1914 publication *Glasarchitektur (Glass Architecture).* Taut later dedicated his *Glashaus* to Scheerbart (Taut, 1920c)**,** and Scheerbart his *Glasarchitektur* to Taut (Scheerbart, 1914).

Sharp continued his elaboration of the Taut–Scheerbart relationship in his 1972 translation of Scheerbart's 1914 *Glasarchitektur* and Taut's 1920 *Alpine Architektur (Alpine Architecture).* In the introductory essay, Sharp (1972) credited *Glasarchitektur* as having laid the programmatic outline for a new glazed architecture, while *Alpine Architektur* was argued as a later attempt to express the *Glasarchitektur* programme in visual terms. Sharp (1972) also identified Taut's 1920 work *Die Auflösung der Städte (The Dissolution of Cities)* as an elaboration of these themes, particularly the schemes contained in *Alpine Architektur.* At this stage, it should also be mentioned that Taut's 1919 publication *Die Stadtkrone (The City-crown)* should be treated as also having had a connection to *Glasarchitektur,* as it championed the use of free-standing structures to effect the planning of entire cities.

With so many purported affinities, the date that Scheerbart met Taut is of fundamental importance to this study, as it may clarify the origins of the *Glashaus*. In her dissertation, Haag Bletter (1973) revealed that buildings made of glass were not a novel idea at the time. Referring to early Jewish and Islamic legends, myths and Renaissance texts, Haag Bletter (1973) confirms that glass had a long history as a mystic medium, for example, it was used to reveal Gnostic knowledge. Over the centuries, numerous diverse cultures revered both glass and crystal as symbols of beauty and truth. Haag Bletter argued that through Scheerbart's influence, these associations were ultimately attached to the *Glashaus*. She also proposed that Scheerbart could have met Taut in early 1912, well before the construction of the *Glashaus* in 1914 (Haag Bletter, 1973 p.79).

It is highly likely that Haag Bletter was correct when she referred to Scheerbart's influence on the formative conception of the Glashaus. This hypothesis is supported by Taut's own 1920 writing, "Glaserzeugung und Glasbaus" ("Glass Manufacture and Construction"), in which he states that he knew of Scheerbart before their first actual meeting. Taut (1920c) stated that he admired Scheerbart's work and that his glass fantasies inspired the Glashaus. In her 1993 article, "Kleine Glashaus – Chronologie" ("Chronology of the Small Glasshouse"), Bettina Held quoted a letter Scheerbart wrote on 11 July 1913 to the glass artist Gottfried Heinersdorff, whom Taut knew through the Werkbund. In this letter, Scheerbart enquired if Heinersdorff knew of any architects who were constructing glazed buildings. Heinersdorff is said to have replied with the information concerning Taut and his Glashaus. This was confirmed by a reply from Scheerbart on 25 July 1913 in which he requested a date and time to meet with Taut, and additionally confirmed his willingness to write about the building. This date was further corroborated by Gutschow in his 2006 article, "From Object to Installation in Bruno Taut's Exhibit Pavilions", in which he stated that Taut started work on the Glashaus in the summer of 1913 while finishing another project. According to Leo Ikelaar (1996), Scheerbart and Taut met for the first time on 30 July 1913. Held (1993) stated that Scheerbart first wrote a preliminary report on the Glashaus in the liberal daily newspaper, the Berliner Tageblatt, on 22 October 1914. The municipal submission drawings of the Glashaus bear the approval date of 25 February 1914, which is when the building permit was issued (Taut, 1914b). Held (1993) further contended that construction work had apparently commenced two weeks prior to the issue of the building permit. Held (1993) also argued that these drawings differ slightly from the four preliminary sketches made public on 1st of January 1914. This confirmed that some degree of design evolution had taken place after Taut and Scheerbart had met. However, what it does not prove is that Scheerbart was instrumental in the initial formulation of the Glashaus' design. Manfred Speidel, in his 1995 book, *Bruno Taut: Natur und Fantasie 1880–1938 (Bruno Taut: Nature and Fantasy 1880–1938)*, contended, like Held and Haag-Bletter above, that Scheerbart met Taut a few months before the construction of the Glashaus, but only after Taut had finished the preliminary sketches. This is supported by Kurt Junghanns (1983), who contended that the Glashaus design was complete by the time Taut and Scheerbart met.

Paul Scheerbart is undoubtedly pivotal to any attempt to discern the origins of the Glashaus. As previously mentioned, his role, first identified in English literature by Reyner Banham and expanded by Dennis Sharp and Rosemarie Haag Bletter, is widely referred to today in almost all literature on the subject (Colquhoun, 2002; Curtis, 1996; Frampton, 2007; Thiekotter, 1993; Watkin, 2005; Weston, 1996, 2004; Whyte, 1982). However, there still remains a lingering doubt about his direct role. Research on Taut now concludes that the influence of Scheerbart has been overstated, especially in regard to the initial conception of the Glashaus.

2.3 Bruno Taut and Adolf Behne

In his dissertation, Gutschow (2005) stated that the Behne had a direct connection to, or influence on, the *Glashaus*. In a similar vein as Sharp (1966), Gutschow (2005) proposed that Behne was a fervent propagandist of the Expressionist label for architecture, particularly the work of Taut, whom Behne believed embodied the emotional and spiritual essence of the Expressionist painters. Gutschow (2005) stated that Behne had expressed his dissatisfaction at the exclusion of architecture from the wider Expressionist scene, and thus actively sought to forge an association between architecture and Expressionism.

Behne first wrote about Taut's work in a March 1913 article in the German artistic and literary magazine *Pan*. In this article, simply entitled "Bruno Taut", Behne immediately applied the Expressionist label, along with associated terms like ‘immerse’, ‘inner-self’, ‘intensity’, and ‘spirituality’. In order to encapsulate Taut’s work, Behne did not merely report and reiterate Taut’s ideas; he actively advanced a programme of classification for Taut’s architecture. According to Gutschow (2005), the 1913 *Pan* article was the first instance where the Expressionism label was applied to Taut’s architecture. With Behne’s 1913 article, Taut entered the avant-garde culture of the period. With the publication of the *Pan* article, Gutschow (2005) argued that Taut’s work would forever be labelled as direct, expressive, anti-historic, deliberately new, and frequently shocking. While convinced that some of these descriptions may be apt for Taut’s work, Gutschow (2005) contended that ‘anti-historic’ did not apply at all: “…Taut had long professed the need to consider continuity with traditions and established archetypes … for Taut, architecture was not primarily about invention” (Gutschow, 2005 p.203)**.** Interestingly, Taut never applied the term Expressionism to his own architecture (Gutschow, 2005 p.192).

In the *Pan* article, Behne also connected Taut’s work with that of Alfred Messel; not, however, as a direct copy, but rather as a continuation of Messel’s spirit of objectivity and directness. This connection is feasible as Taut completed a 1910 competition entry for the expansion of Messel’s famous 1896 Wertheim Department Store. Taut himself praised the clarity, dignity and nakedness of the building in a letter he wrote to his brother Max following his first visit to Berlin in 1902 (Whyte, 1982 p.17). The store was built around a central atrium that extended upward to the third level, exposing the ironwork of the stairs to the interior galleries of the building. In a similar manner, the galleries were also exposed to the interior central core, with glass walls being used to subdivide internal gallery spaces, all of which were lit with electric lighting (Whyte, 1982)**.** Gutschow (2005) contended that Messel was a father figure of modernist architecture to the people of Berlin, exemplified in the stained glass and powerful structural expression of the Wertheim façade. Gutschow (2005) continued his elaboration of Taut and Behne’s deepening relationship through a reading of Taut’s 1914 article “Eine Notwendigkeit” (“A Necessity”), which was published as a prelude to the *Glashaus*.

In “Eine Notwendigkeit”, Taut (1914a) elaborated on his desire to construct a building that was the collective endeavour of architects and artists, in particular

Figure 2 The *Amsterdam Bersus* (Image: www.commons.wikimedia.org).

painters. He sought a house in which architecture could once again merge with the arts, much like a Gothic cathedral that was the 'entirety' of all of artistic endeavours. This entirety, or collective endeavour, was proposed by Taut (1914a) as a 'secret' or 'great architecture'. Such architecture, much like the great Gothic Cathedrals, need not be finished by any one generation. Building, Taut continued, must be everything at once, both frame and content, set free from practical demands. He proposed a house in which art was to be displayed and kept safe, a building that might contain rooms for all manner of artistic endeavour. The ideal building he envisaged was to have been an artistic organism that contained great stained-glass windows; the walls in Cubist rhythms; the paintings of Wassily Kandinsky and Franz Marc; the columns decorated by Alexander Archipenko; and the ornament provided by Heinrich Campendonk. Furthermore, the proposed building should also be close to a metropolitan area and located on an open site (Taut, 1914a). This last point recalls the site of the *Glashaus*, which was built at the fringe of Cologne on an 'open' site. Haag Bletter referred to Taut's "Eine Notwendigkeit" as the first manifesto calling for an Expressionist architecture (Washton Long, 1993 p.124).

However, at the time, the notion of a collective 'art house' or 'temple' was a much more general idea and not exclusive to either Taut or Scheerbart. Gutschow traced the evolution and connection of this idea back to Scheerbart's earlier literary works, which contained images or worlds flooded with glass, colour, music and motion. He also traced the concept of collaborative artistic endeavour (*Gesamtkunstwerk*) to Taut's own earlier involvement with the Darmstadt artistic colony. Furthermore, the concept of the *Volkshaus* (People's House) was initially introduced to Taut by his former teacher and employer Theodor Fischer. Fischer (1906) published his *Volkshaus* concept in "Was ich bauen möchte" ("What I would like to build") in which he proposed the construction of popular cultural centres in the form of a house for all people. These centres would have consisted of coloured multifunctional halls that would have exhibited art, held performances and hosted events of all kinds, with no other purpose other than to lift the people's spirits. Fischer constructed a number of 'People's Houses' in Stuttgart, Pfulllingen and Worms, while Taut was working for him from 1904 to 1908 (Gutschow, 2005)**.** However, they were by no means similar in any way other than concept.

Furthermore, Gutschow (2005) identified Hendrick Berlage as having been important to the development of "Eine Notwendigkeit". This connection was primarily established through Berlage's 1908 *Grundlagen und Entwicklungen der Architektur (Foundations and Development of Architecture),* which Gutschow (2005) identified as having had uncanny parallels to the writing of not only Taut but also Behne. Taut supposedly became aware of this article through Behne, and requested a copy from Behne in April 1913 (Gutschow, 2005 p.250).

In turn, "Eine Notwendigkeit" has also influenced later important documents; Marcel Franciscono goes so far as to say that Gropius' *Bauhaus Manifesto and Programme* of 1919 was essentially a direct copy of the 1914 "Eine Notwendigkeit" essay (Franciscono, 1971 p.91)**.**

Gothic architecture was likewise mentioned by Gutschow (2005) as an additional precedent that influenced Taut's "Eine Notwendigkeit", and by implication also the *Glashaus*. He contended that in Germany the reverence for the Gothic dated back to early romanticism, with Goethe, Hegel and the Schlegel brothers all having praised the Gothic's spiritual and architectural virtues (Gutschow, 2005 p.253). Taut explicitly discussed the Gothic in "Eine Notwendigkeit". Prior to 1914, Behne had earlier written on the Gothic in 1911 in his article, "Peter Behrens und die Toskanische Architektur des 12. Jh" ("Peter Behrens and Tuscan Architecture of the 12th Century"). In this article, Behne developed the thinking of his PhD dissertation by contrasting Peter Behrens' Exhibition Pavilions with Tuscan Gothic church ornamentation. Furthermore, in a 1914 article "Die Gotische Kathedrale" ("The Gothic Cathedral"), Behne wrote a technical description of the masonry, pointed arch, ribbed vaulting and the historical origins of the Gothic. Behne (1914) even praised the Gothic as the greatest achievement of architecture. In addition, Berlage directly referenced the Gothic in the façade and planning of his *Amsterdam Bersus* (Amsterdam Commodities Exchange) building of 1903 (Figure 2). Some historians have noted that Taut had the opportunity to visit the *Amsterdam Bersus* during a trip to Holland in 1912 (Hartmann, Nerdinger, Schirren, & Speidel, 2001).

2.4 Bruno Taut and the Gothic Style

The extent of the influence of the Gothic on the period is explained by the powerful impact of Wilhelm Worringer's *Formprobleme der Gothik (The Problem of Form in Gothic)* of 1910 (Gutschow, 2005 p.252-4). Worringer's work exerted a profound influence on the Gothic reception of the time, but also on Expressionist thinking. According to Gutschow, Worringer was especially influential on Behne and it is reasonable to assume that Taut was familiar with his work too. Worringer (1910) proposed that the form of the Gothic was the result of the will and intent of the artists involved, rather than an expression of a wider artistic cycle. He further made a call for a new abstract art that was drawn from both the intuition and the serrated geometry of the East and the Orient. This new art form would thus transcend the chaos of the modern era through the creation of architecture that reflected order, truth, and spiritual clarity. In other words, a new architecture that was similar in spirit to that of the great Gothic cathedrals and associated stained-glass painters. He further proposed a new art that was both independent and autonomous, and that was based on an intuitive, emotional and creative artistic

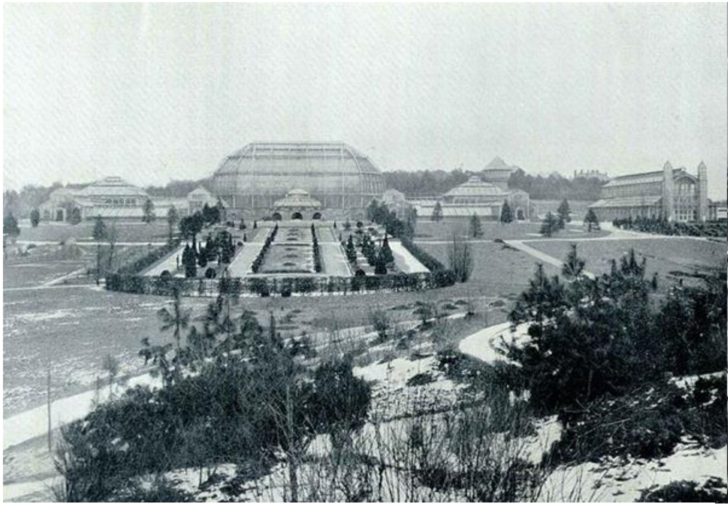


Figure 3 Left - Alfred Koerner's 1907 Palm house (centre) and Subtropical House (extreme right) (Image: www.commons.wikimedia.org).
Figure 4 Right - Strasbourg Cathedral's western facade (Image: www.commons.wikimedia.org).

awareness of form (Worringer, 1910). Interestingly, Taut also made similar connections to the East and the Orient in his 1919 articles, "Ex Orient Lux: Aufruf an die Architekten" ("From the Oriental Light: A call to Architects") and "Für die Neue Baukunst" ("For the New Construction").

Scheerbart's *Glasarchitektur* (1914) also made reference to the Gothic; he contended that a new, revolutionary glass architecture was impossible without reference to the Gothic. Scheerbart discerned a key example in Alfred Koerner's 1907 glasshouse complex at the Berlin Botanic Gardens, in the suburb of Dahlem (Figure 3). The main façade of one of these glasshouses, the Subtropical House, was similar to Berlage's Amsterdam Commodities Exchange in that it was reminiscent of the three spire main elevation of a typical Gothic cathedral. The Berlin Botanical Gardens would have undoubtedly been familiar to Taut. In the book *The Glasshouse* (2005), John Hix referred to the Palm and Subtropical Houses at Dahlem as prototypes for German Expressionism because they followed a pure structural function as chambers for plants. Likewise, Behne, in his 1914 essay, "Die Gotische Kathedrale", cited the example of Strasbourg Cathedral as having been an exemplary example of Gothic architecture (Figure 4). In 1772, Goethe dedicated his "Von Deutscher Baukunst" ("On German Architecture") to Erwin von Steinbach, the builder of the Strasbourg Cathedral. Taut wrote about the Gothic in his 1904 article "Natur und Baukunst" ("Nature and Architecture"), and made direct reference to

Strasbourg Cathedral in his articles "Ex Orient Lux: Aufruf an die Architekten" and in a letter he wrote to the 'Crystal Chain' group on 28 January 1920 (Whyte & Taut, 1985). In, "Ex Orient Lux", Taut praised Strasbourg Cathedral as being comparable to the wonders of the Orient, while in a 1920 letter, he recalls his ecstasy while climbing the bell-tower of Strasbourg Cathedral.

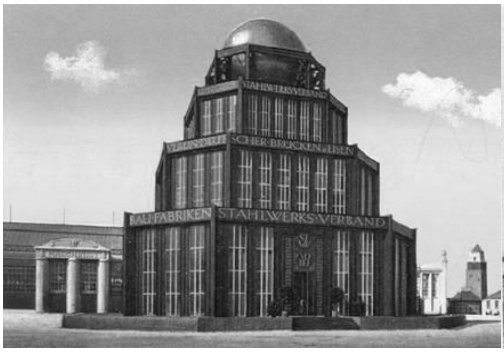
2.5 Bruno Taut, other influences and precedent buildings

Apart from the Gothic, Gutschow (2005) also listed the Greek *Omphalus* and the Mamluk tombs near Cairo, Egypt, as precedents possibly influencing the *Glashaus* design. Although, in his essay, "Grab, Altar und Nabel: Der Delphische

Figure 5 Robert Delaunay's painting *A Window* (Image: Thiekotter, 1993).

Omphalos" ("Grave, Altar and Navel: The Delphic Omphalos"), Matthias Schirren (1993) explored the connection to the Greek *Omphalos*, but concluded that there was no evidence to suggest that Taut even knew of it.

In a discussion of the colours of the *Glashaus* dome, Gutschow (2005) quoted Thiekotter's (1993) argument that the choice of colours (yellows, blues and greens) were, in all probability, derived from Robert Delaunay's painting *A Window*, painted during the period 1912 to 1913 (Figure 5). According to Thiekotter, Berlin's famous Sturm Gallery held a Delaunay exhibition in January 1913, which included this work. Likewise, in April 1913, the Sturm Gallery also exhibited a model of the *Glashaus* (Thiekotter, 1993)**.** Additionally, in "Eine Notwendigkeit", Taut stated that the stained glass of the building that he proposed should comprise the luminous qualities of the compositions by Delaunay.



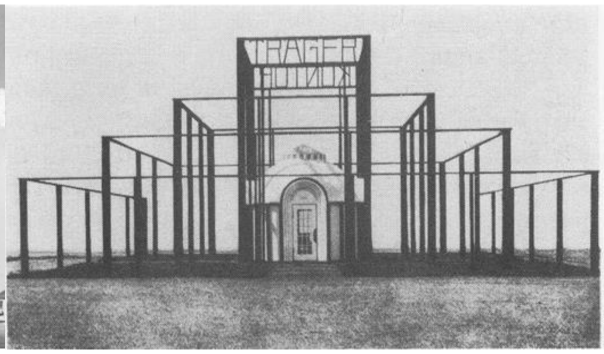


Figure 6 Left - Bruno Taut's 1913 *Monument des Eisens* (Image: www.commons.wikimedia.org).
Figure 7 Right - Bruno Taut's 1910 pavilion for the Träger-Verkaufs-Kontor firm at the 2nd Ceramic, Cement and Lime Industries Exhibition (Image: Whyte, 1982)**.**

Gutschow (2005) quoted Speidel's (1995) contention that Scheerbart was responsible for the glass lamps and double-glazing in the main glazed Dome Room, as well as the mystical numerology woven into the entire design. Gutschow, likewise, quoted Regine Prange (1994) from her article "The Crystalline", in contending that Scheerbart was responsible for the glass floor and inner partitions in the Dome Room, as well as the electric lighting and the kaleidoscope. As mentioned above, Taut was clearly responsible for the overall design of the *Glashaus*; the circulation through the building; the geometry; reinforced concrete structure; coloured glass of the dome; and the water cascade in the lower level (Gutschow, 2005). Furthermore, as discussed above, Gutschow also stated that Behne was the propagandist for the *Glashaus*. Gutschow thus concluded that the

Glashaus was an equal partnership that comprised of Taut, Scheerbart and Behne: "Each of them – the architect, the visionary, and the critic – was equally important in that enduring creation" (Gutschow, 2005 p.272). Gutschow's argument was that while Behne and Taut shared an intimate intellectual connection, Behne effectively manoeuvred and moulded the architectural identity of Taut as an Expressionist. Thus, Behne, as the most prolific writer on Taut, the *Glashaus* and Expressionism, used the *Glashaus* to contrive an Expressionist movement within architecture (Gutschow, 2005). It would therefore appear that, like Scheerbart, Behne made an important contribution to Taut's evolution as an architect. The problem, however, is that Behne also had an undue influence over the reception of Taut's work. What is unclear is their contribution to the initial design of *Glashaus*, or whether their contributions were inflated retrospectively after the design was complete.

Sharp (1966) has stated that before World War One, Taut experimented with prefabricated construction and the materials of glass, steel and concrete. He identified a key example as being the 1913 *Monument des Eisens* (Steel Industries Pavilion), which Taut constructed with Franz Hoffmann for the Leipzig *Internationale Baufach-Ausstellung* (International Building Trade Fair) of that year (Figure 6). Similarities between this building and the Glashaus included the plan, façade, framing of façade elements, inscriptions on the horizontal façade elements and the layering of the form. Despite their constrained size and external appearances, the Monument des Eisens and the Glashaus represented two of the most aesthetically and technologically advanced buildings in the world at that time (Sharp, 1966 p.88). Interestingly, the Monument des Eisens was not the first of Taut's exhibition works; he had also produced a pavilion for the Träger-Verkaufs-Kontor firm at the 2nd Ceramic, Cement and Lime Industries Exhibition in Berlin in 1910 (Figure 7). Iain Boyd Whyte's (1982) book Bruno Taut and the Architecture of Activism was the first text in English to mention this pavilion. In this book, he closely echoed Banham (1959) by arguing that many of the formative roots of modern architecture were not functional and technologically driven, but rather mystical, illogical and utopian. Whyte (1982) explained that the 1910 pavilion consisted of an open steel frame that spanned a smaller domed gazebo at its centre, with no connection between frame and gazebo. This separation thus accentuated the geometric minimalism of the frame with the careful detailing of the central gazebo that Whyte (1982) explained as a tempietto. Gutschow in his 2006 article, “From Object to Installation in Bruno Taut’s Exhibit Pavilions”, contended that Taut’s three pavilions and especially the Glashaus’ significance has only in part been recognised, and remains thus largely misunderstood.

Gutschow (2006) compared Taut’s 1910 pavilion to the work of Peter Behrens, arguing that it was partially reminiscent of Behrens’ exhibition pavilions in its obvious volumetric character, bare symmetry and aesthetic sensibility. However, it also differed from Behrens’ pavilions in that it abandoned obvious references to the

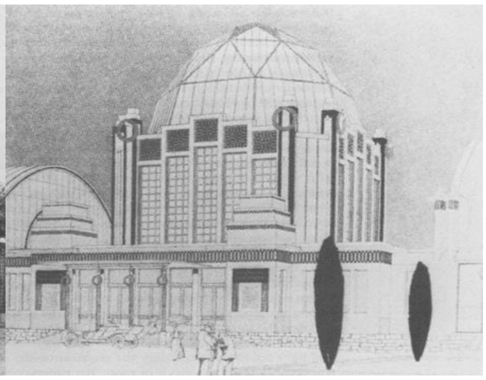


Figure 8 Left - Reibedanz Laundry (Image: Whyte, 1982).
Figure 9 Right - Franz Roith’s 1907 project for a swimming pool (Image: Whyte, 1982).

Tuscan Gothic and historic precedents. Annette Ciré (1993), in “Exponat und Monument: Bildbeispiele zur Bautypologie des Glashauses” (“Exhibit and Monument: Image Examples of the Typology of the Glasshouse”), likewise explored the earlier exhibition pavilions of Fritz Drechsler’s Cement Pavilion at the Exhibition of the Cities of 1903, and Bruno Möhring’s Puhl & Wagner pavilion for the Clay, Cement and Lime Industry Exhibition, Berlin in 1902. Similar to the Glashaus, Möhring’s design included the use of glass mosaics. In describing Taut’s 1910 pavilion, Ciré (1993) stated that it consisted of a delicate white tempietto that was located at the centre of a black and red painted steel structural ziggurat. Ciré (1993) further described the Monument des Eisens as having consisted of a dark blue painted iron stepped skeleton, contrasted with gold lettering, with a golden orb placed at the highest point. The result was a clear distinction between structure and infill elements (Cire, 1993 p.128). Gutschow (2006) explained the interior of the

Monument des Eisens as having comprised a large area for display, with the ground floor decorated in sparkling red, black and gold glazed tiles that were indicative of the German national colours. The plan consisted of an outer exhibition area for architectural models and product displays, while a large concentric, darkly lit inner space was used to exhibit photographic transparencies that were lit from behind. Interestingly, the function of this central space has distinct echoes of the kaleidoscope that was used in the Glashaus. It also brings into contention the earlier claim by Prange (1994) that Scheerbart was responsible for the kaleidoscope.

Gutschow (2006) continued his explanation of the *Monument des Eisens* by stating that steps led to a double-volume vaulted cinema above the display area. In this cinema, short films were shown that depicted steel being used in construction. The cinema was clad in a sumptuous deep purple cloth, designed by Franz Mutzenbecher (Gutschow, 2006). Again there are strong associations with the *Glashaus*, in that the kaleidoscope room was also clad in violet-coloured velvet (Thiekotter, 1993 p.61).

Apart from the connections to Taut's two earlier pavilions, Whyte (1982) also cited a connection to three earlier residential buildings that Taut undertook: two residential façades in Berlin's Neukӧln district in *Kottbusser Damm* (in 1910 and 1911), and one complete residence in the Chalottenberg district (in 1911). Whyte (1982) further noted a 1914 façade for the Reibedanz Laundry in the Tempelhof

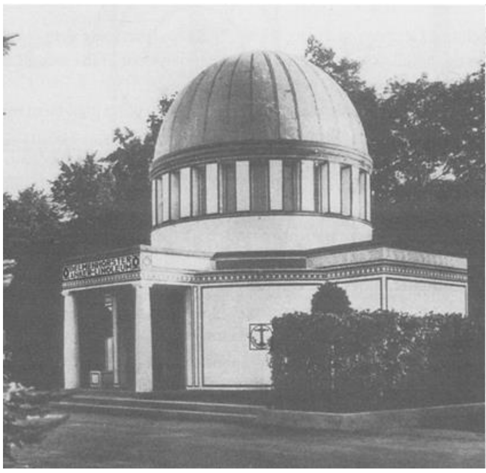
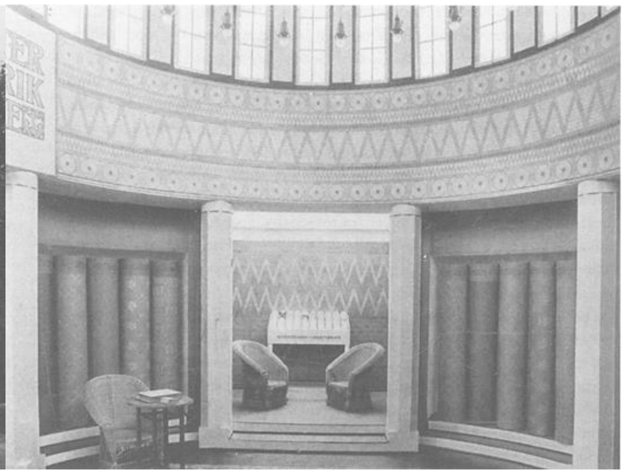



Figure 10 Left - Exterior of Peter Behrens' 1906 pavilion for the Delmenhorst Linoleum Company (Image: Maciuika, 2005).
Figure 11 Right - Interior of Peter Behrens' 1906 exhibition pavilion (Image: Whyte, 1982).

district of Berlin (Figure 8). Interestingly, three out of these four commissions are for façades only. Tillman Buddensieg (1977) argued that this focus on façades, particularly as evident at 2/3 Kottbusser Damm, Neukölln*,* was connected to Taut's interest in Cubist paintings that portrayed three-dimensional forms. Whyte (1982) identified a further architectural precedent for the *Glashaus* in Franz Roith's 1907 project for a swimming pool in Vienna, Austria (Figure 9). Roith's building remained un-built, but it had an entrance pavilion based on an octagonal plan (like Taut's *Monument des Eisens*); glass bricks for the construction of the walls; and a prismatic dome above the central space. It was thus highly probable that Roith's building served as a direct influence for the *Glashaus* (Whyte, 1982).

Peter Behrens' work, particularly his 1906 exhibition pavilion for the Delmenhorst Linoleum Company at the Third German Applied Arts Exhibition in Dresden, has been identified as significant to Taut's *Glashaus* (Figures 10 and 11). In his book, *Before the Bauhaus: Architecture, Politics, and the German State, 1890-1920*, John Maciuika (2005) described the 1906 pavilion as a temple-like structure that adapted classical forms to contemporary commercial and industrial function. Religion was referenced through the use of a dome over a central plan in a manner typical of a Christian church. All the building's elements and decorative forms employed the basic geometry of the circle and square, having been derived and modified from the religious inspired central-plan. The classical symmetry, proportion and formal clarity of Behrens' 1906 pavilion were expressive of industry, commerce and culture. The exterior of the building was, like Taut's *Glashaus* and Reibedanz Laundry, inscribed above the entrance with the Delmenhorst Linoleum Company's name and logo. Behrens' 1906 pavilion also incorporated an exterior pool, while the interior contained the products of the Delmenhorst Linoleum Company. The floor beneath the central dome was decorated with square-shaped decorations, which contained an intertwined design of 'forest creatures' (Maciuika, 2005 p.156). Furthermore, the walls and friezes were opulently patterned in company materials, which illustrated the full potential and possibilities of company materials when placed in the hands of artists. Rolls of company linoleum were located in recesses adjacent to the central domed space and were emphasised by the monumentally high dome and vertical windows above. The enormous classical effect of the interior was further emphasised by the framing of these recesses by eight-sided columns (Maciuika, 2005). Located on the underside of the dome were suspended, spherical, electric light fittings; this is strikingly similar to Taut's interior lighting arrangement to the *Glashaus.*

Figure 12 Left - The pagoda like towers of Berlin's Luna Park (Image: McBride, 2006)**.**
Figure 13 Right - Exterior of Adolf Loos' American Bar (Image: www.commons.wikimedia.org).

Douglas McBride (2006) made a further reference to both a temple and monument in his article, "Modernism and the Museum Revisited". Echoing Thiekotter's (1993) earlier work, McBride (2006) stated that the pagoda-like towers of Luna Park were the inspiration for the *Glashaus* (Figure 12). Established in 1904, Luna Park was an amusement venue located in the Halensee district of Berlin. The two towers, or pagodas, were each set on columns and had a 'crown' of coloured glass that had a dramatic effect when lit at night. Each tower had a terraced staircase that consisted of five flights, while each pairing of towers and associated staircase was split by a central water cascade (McBride, 2006)**.**

Adolf Loos' 1908 American Bar which is located at Number 10 *Kärntner Durchgang* in Vienna, Austria is of significance because it, like Taut's *Glashaus,* used Luxfer Prisms (Figure 13). While it could be argued that Taut must have known of Loos and his work, whether Taut was aware of his Loos' bar is yet to be established. Loos was one of the first authors to have been published in Herwarth Walden's *Der Sturm (The Storm)*, of which Behne was a principal contributor and theorist

(Gutschow, 2005). Walden, as a proponent of the German avant-garde in art and culture, established the highly successful Sturm Gallery, where Behne first became acquainted with modern art and artists (Gutschow, 2005). Taut himself published his “Eine Notwendigkeit” in the February 1914 edition of *Der Sturm*, and further exhibited a model of the proposed *Glashaus* at the Sturm Gallery in April 1913 (Thiekotter, 1993 p.170). Thus, it is highly probable that Taut, at the very least, knew of Loos.

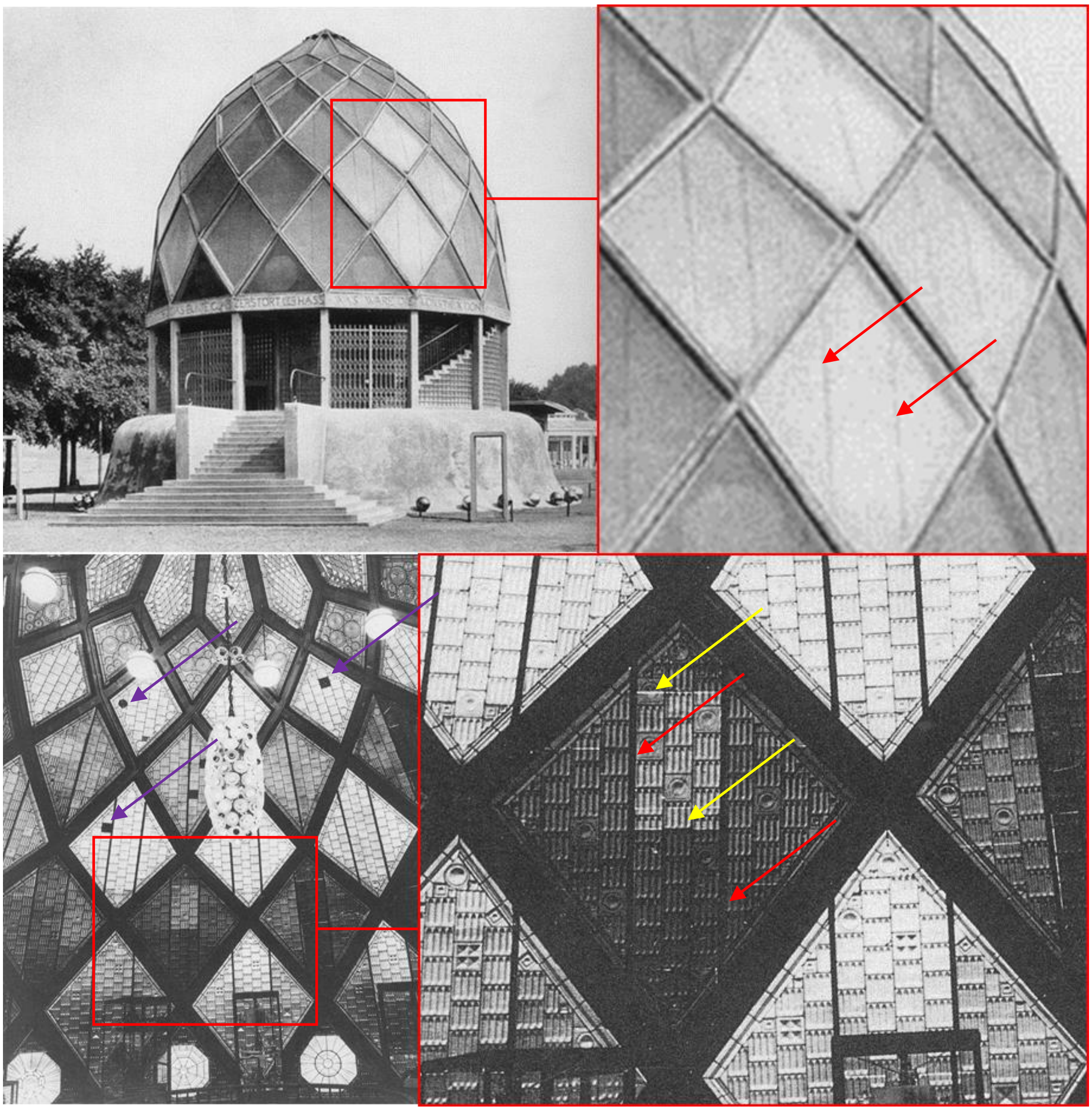


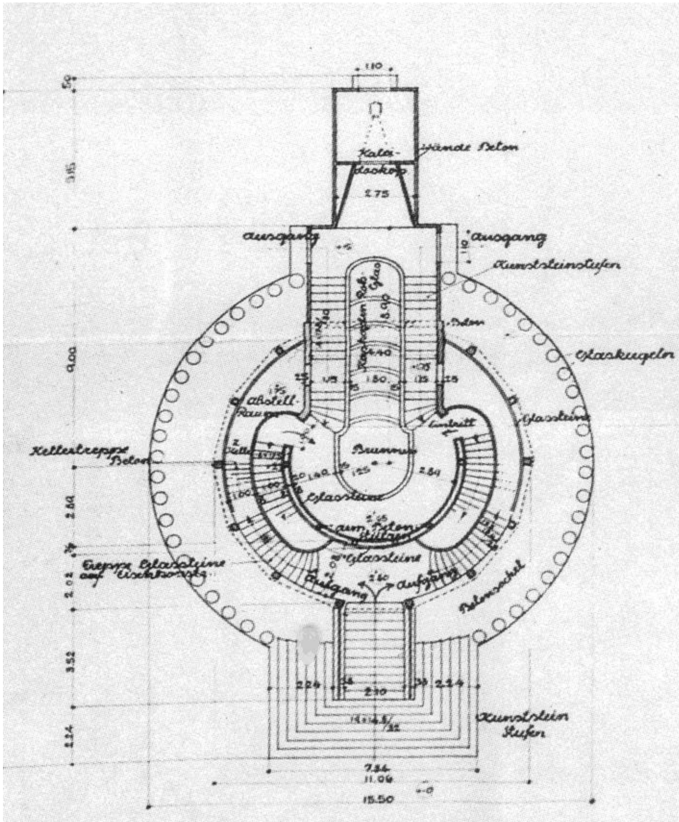
Figure 14 Interior and exterior of *Glashaus'* dome illustrating the third skin of glazing. The red arrows indicate the vertical iron rods. The yellow arrows indicate the presence of a third 'skin' to the interior of the *Glashaus* dome, which appears to 'cut' the Luxfer prisms horizontally. While the vertical lines of the iron rods are evident on exterior images of the *Glashaus*, the horizontal 'cuts' to the Luxfer prisms are not. This would indicate that there is a third interior skin. The purple arrows supposedly indicate the presence of individually coloured Luxfer prisms (Images: Thiekotter, 1993).

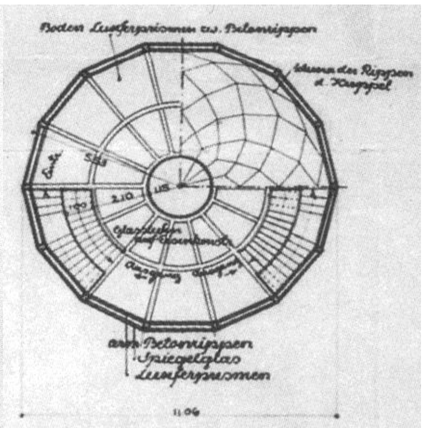
The exterior of Loos' American Bar features a projecting translucent awning. This awning comprises a three-sided prism arrangement, with glass skins of Luxfer Prisms above, an exterior stained-glass skin below and an onyx marble skin to the interior. The stained-glass skin assumes the stylised appearance of the national flag of the United States of America. During the day, sunlight behaves in two ways. First, it enters through the upper Luxfer Prism skin and is then infused with colour from the red, blue, yellow, green and white stained-glass skin below. This produces diffused colour lighting to the exterior of the bar. Secondly, sunlight enters in a similar manner through the Luxfer Prisms, but is then diffused to the interior of the bar through a skin of red-brown onyx marble tiles. At night, the interior electric lighting of the bar diffuses light outward in the reverse of the daytime scenarios. Loos is quoted as having described his American Bar as a "…little jewel…" (Gravagnuolo, 1995 p.117)**.** This statement is strikingly similar to Thiekotter's later account in which she described the *Glashaus*' night-time appearance as having been a "…glittering, sparkling jewel" (Thiekotter, 1993 p.11)**.** In a similar vein, Behne referred to Taut's Cupola Room as having been "…vaulted like a sparking skull" (Behne, 1915 p.4)**.**

2.6 Bruno Taut and the use of colour

Both the colours and construction methods of the awing to Loos' American Bar are startlingly similar to Taut's *Glashaus*. The colours of the *Glashaus* dome started at its base in deep blue and progressed upward through moss-green, then golden yellow and eventually culminated at the apex in brilliant creamy white (Taut, 1919a p.13)**.** In contemporary literature, descriptions of the *Glashaus* dome's colours are described almost identically, except for the colour at the apex, which was described as luminous pale yellow rather than creamy white (B. Richards & Gilbert, 2006; Thiekotter, 1993). While red was not directly present in the *Glashaus* dome, it was located in close proximity on the walls of the 'crypt' or Cascade Room below (Thiekotter, 1993 p.58)**.** The construction of the *Glashaus* dome also contains similarities to Loos' American Bar in that Taut employed numerous skins of glazing to add 'character' or colour layering to the light. The glazing of the *Glashaus* consisted of an exterior skin of clear plate glass and an interior skin that consisted of pastel-coloured plate glass. Between the inner and outer skins of plate glass, a third layer of Luxfer Prisms was used. Narrow iron profiles divided the Luxfer Prisms vertically. These iron profiles also extended to the interior coloured-glass skin (Thiekotter, 1993 p.46).

There is some contention as to how many glazed skins were present in the *Glashaus*' dome (Figure 14). Many commentators have described the dome as double-glazed rather than triple-glazed (Ching et al., 2007; Sharp et al., 1972; Speidel, 1995). Speidel (1995) even attributed the double-glazing to Scheerbart. Yet, Thiekotter (1993) made a strong argument for three skins based on an image of the *Glashaus* that clearly showed an additional skin of coloured glazing within the





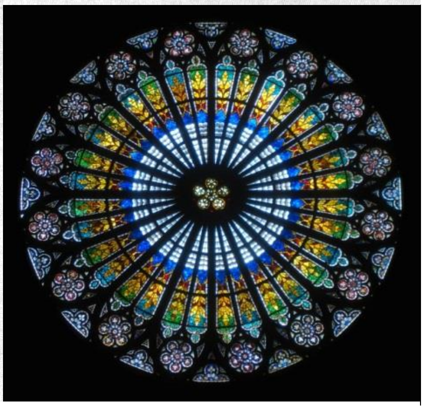


Figure 15 Left - Plan of the *Glashaus'* Cascade Room. (Image: Taut, 1914b).
Figure 16 Right top - Plan of the *Glashaus*' Dome Room (Image: Taut, 1914b).
Figure 17 Right bottom - Strasbourg Cathedral's western rose-window (Image: www.flickr.com).

interior. This third skin was only evident on certain, and not all, of the *Glashaus'* rhombic panels, and always in conjunction with the vertical steel profile. Further complicating the issue of colour and glazing, this same image showed that only a very small number of the Luxfer Prisms appear to be 'coloured'. However, Taut wrote that "…the inner face of the dome was composed of small thick glass plates with an uneven surface. These plates effectively kept out external views and turned the daylight coming in into a soft powdery luminosity without shadows. …There was always a diffused glow…" (Taut, 1919c p.266).

Taut (1920c) viewed glass, especially coloured glass, as originating from the earth. Taut thus referred to glass as 'melted earth'. He distinguished glass from other materials for its mystical and illusion creation qualities. This is because even though glass was made from earth, it could equally create the illusion of, or mystic associations with, the elements of water, air, fire or ice. Glass overcame its earthy weight and became a delicate piece of crystal. For Taut (1920c), the amount of effort required to recover glass from the earth was proportional to its capacity to convey human emotion. Human emotion was in turn proportional to the colour, luminosity and preciousness of the metal used to colour the glass: gold was used for red; silver for yellow; copper for blue and green; nickel for violet; and iron for brown (Taut, 1920c p.12)**.**

What ultimately emerges from an argument concerning both the colours and construction techniques of the *Glashaus*' dome is the realisation that inconsistencies are evident. Taut (1919c) stated retrospectively that the inner face of the dome comprised "small thick glass plates with an uneven surface", i.e. Luxfer prisms. Referring to photos of the interior of the *Glashaus* dome seems to indicate that Taut's statement is correct, but only for certain rhombic panels of the dome. For the remainder of rhombic panels, Thiekotter's (1993) argument that were three skins of glazing appears to be correct. Further evidence is needed to confirm if Luxfer prisms were ever available in any other 'colour', or whether they were only available as clear tiles. If indeed this is correct, then it is logical to conclude that the rhombic panels with only two skins would have been clear, meaning only those panels with three skins were coloured. This has a direct implication on the belief that the *Glashaus* dome rose in solid concentric horizontal bands of colour. It could be argued that the *Glashaus* dome rose in vertical strips of colour that started at their base in blue and ended in white; i.e. these coloured vertical portions had three skins. Following this line of reasoning, these vertical strips of colour were apparently divided by vertical strips of clear glazing; i.e. these vertical clear portions had two skins; hence, the conclusion that the *Glashaus'* dome comprised both double- and triple-glazed portions.

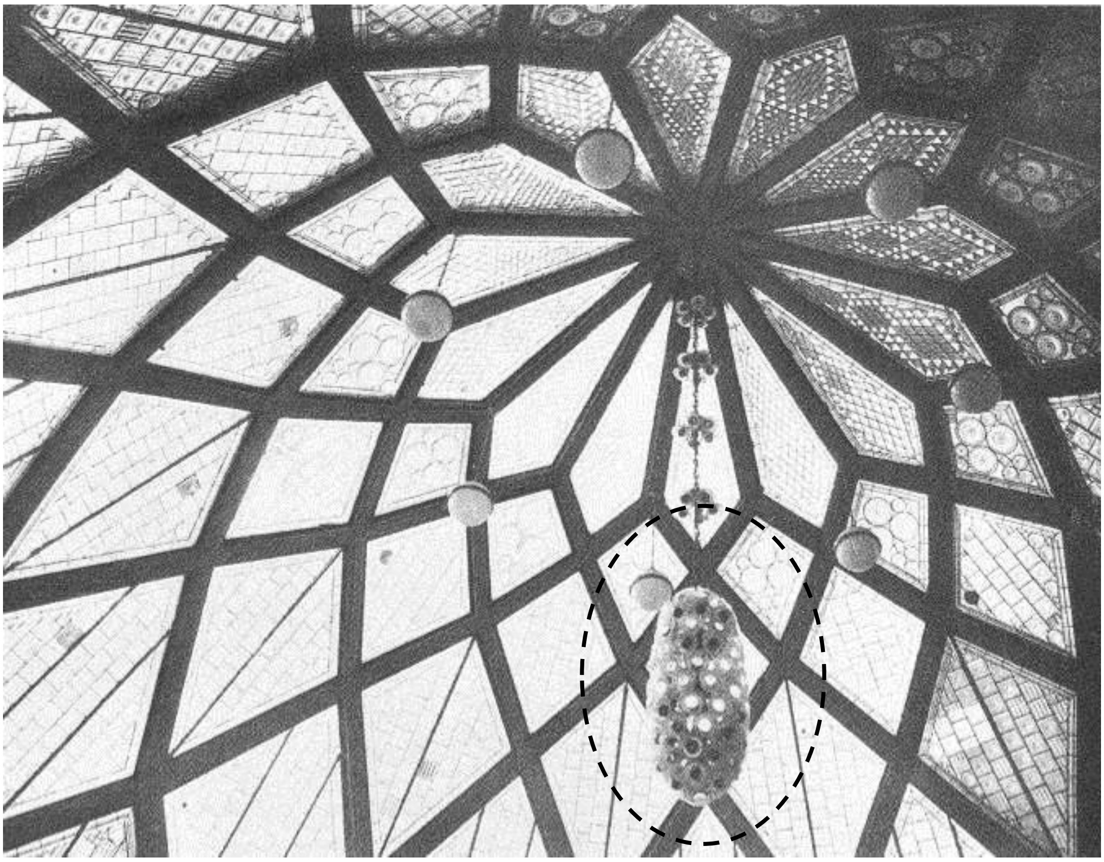


Figure 18 Electric Lighting to the *Glashaus* dome. The dashed circle indicates the element that is similar to the central motif at the centre of Strasbourg Cathedral's western rose-window (Image: Thiekotter, 1993).

The inspiration for the choice of colours used could be traced to Strasbourg Cathedral which Taut visited, years after the construction of the *Glashaus*, in 1920 (Whyte & Taut, 1985 p.46). The Gothic cathedral has already been identified as central to Taut's thinking, and it is therefore appropriate that mention of it, even if retrospective, should be investigated. One of the most significant features of Strasbourg Cathedral is the magnificent rose window on its western façade (Figure 17). A closer investigation of this rose window reveals that it too has the colours red, blue, yellow, green and white, arranged in concentric circles. The colours start with an outer ring that comprises a mixture of light blue and moss-green; this is followed by inner circles of yellows and reds; then a smaller concentric circle of deep blue; and finally, numerous inner concentric circles of clear glazing. While the sequence of Strasbourg's colours does not match Taut's *Glashaus* (deep blue, through moss-green, then golden yellow and eventually brilliant creamy white), the overall selection of colours undoubtedly does. What is also strikingly similar between the Strasbourg rose window and the *Glashaus* are their overall planning arrangements. Strasbourg's rose window consists of three portions: an outer rim in-filled with 16 circular and 16 triangular patterns; a broad central ring that comprised a series of concentric circles of colour that are subdivided by 28 radii; and a small inner dark hub with a circular cluster pattern at its centre. By examining the floor plans of Taut's *Glashaus*, it becomes obvious that the overall planning consisted of a series of concentric circles (Figures 15 and 16). Thus, Taut's plans could, like Strasbourg's rose window, be argued as having consisted of three primary parts: an outer rim that comprised the curved concrete base with a series of spherical glazed spheres at the periphery; a central space of concentric circles that constituted the glass stairways to access the dome above and the Cascade Room below; and an inner central darker space that contained an oculus to view the central water feature below the dome. Interestingly, the water feature was also rimmed with glazed spheres. Taut overlaid his concentric circular plan with a single diagonal axis that acted as both the main entrance podium and the exit, and also included the kaleidoscope room. A comparison of the plan of the *Glashaus*' dome to that of the rose window of Strasbourg asserts more strongly the argument for concentric circles.

The clustered circular geometry at the centre of Strasbourg's rose-window can be proposed as conceptually similar to the light that hung in the centre of *Glashaus* dome (Figure 18). Likewise, the glass spheres that surrounded the base of the *Glashaus* dome could also be proposed as similar to of the 16 rosette forms present at the periphery of Strasbourg's rose window. Alternatively, the 16 rosettes of Strasbourg's rose window could be the 14 octagonal figures that were present at the base of the *Glashaus* dome's glazed skin.

Another remarkable similarity between the Strasbourg rose window and the *Glashaus* emerges when comparing the brightly coloured, outer half of the broad central ring of the rose window to the glazed stairways of the *Glashaus*. As previously mentioned, Taut (1920c) was invested in the idea of coloured glass being able to transmit different degrees of human emotion. Considering that the brightly coloured central ring of the rose window aligns uncannily with the semi-circular stairways of the *Glashaus*, it is plausible that the notion of the staircase leading from one emotional experience to the next was conveyed in the multitude of colours, as evident in the broad central ring of the rose window. This would tend to indicate that the staircases were significant features and deserve further study. It is thus possible that Taut took the original 'inspiration' of the two-dimensional Strasbourg rose window and recreated it as an elevated, three-dimensional form for his *Glashaus*.

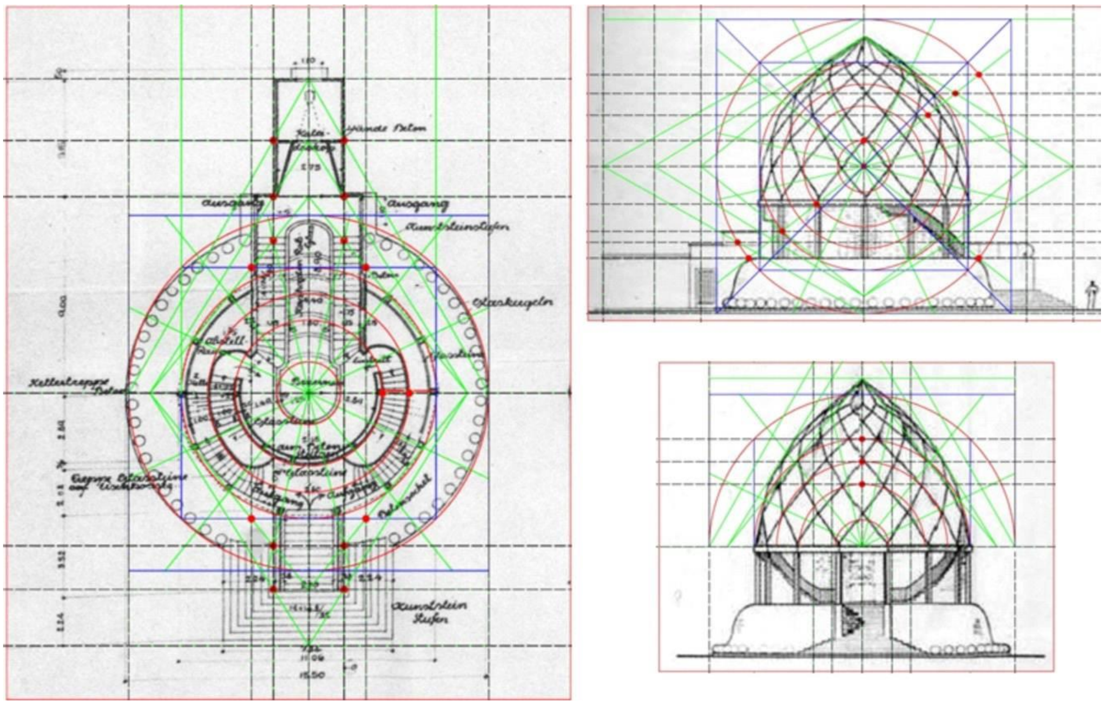


Figure 19 Geometric planning inherent in the *Glashaus* (Original overlaid images:Taut, 1914b).

Alternatively, could the development of the *Glashaus'* plan, been guided by some mystical geometrical formula? Robert Bork, writing in his 2005 article "Plan B and the Geometry of Façade Design at Strasbourg Cathedral, 1250–1350", contended that the design of Strasbourg Cathedral's western façade (containing the western rose window) was derived from a geometric formula. Bork argued that the 'seed' of this formula derived from the inscription of a circle within a square, which resulted in an octagon. He subsequently overlaid this geometric 'seed' onto both the plan and elevation of the western façade of Strasbourg, and in doing so showed that the elevation derived from repetitions of the 'seed' (Bork, 2005). When a similar geometric methodology was applied to the *Glashaus'* plan and elevations, it would appear as if both plan and elevations derive from the same 'seed' conception (Figure 19). Interestingly, when the *Glashaus'* plan was overlaid onto the western façade of Strasbourg cathedral, numerous similarities in proportion became evident (Figure 20). However, this comparison of geometric 'seed' and overlaying of plan only indicates provisional conclusions that should be substantiated through further study. Clearly, there is an as yet unexplored, strong relationship between Gothic architecture, in particular as embodied in Strasbourg Cathedral, and Bruno Taut's *Glashaus*.

2.7 Horticultural glasshouses and the *Glashaus*

In his dissertation *Seeing Through Glass: The Fictive Role of Glass in Shaping Architecture from Joseph Paxton's Crystal Palace to Bruno Taut's Glashaus*, Ufuk Ersoy (2008) argued, like Banham (1959) before him, that the history of glazed

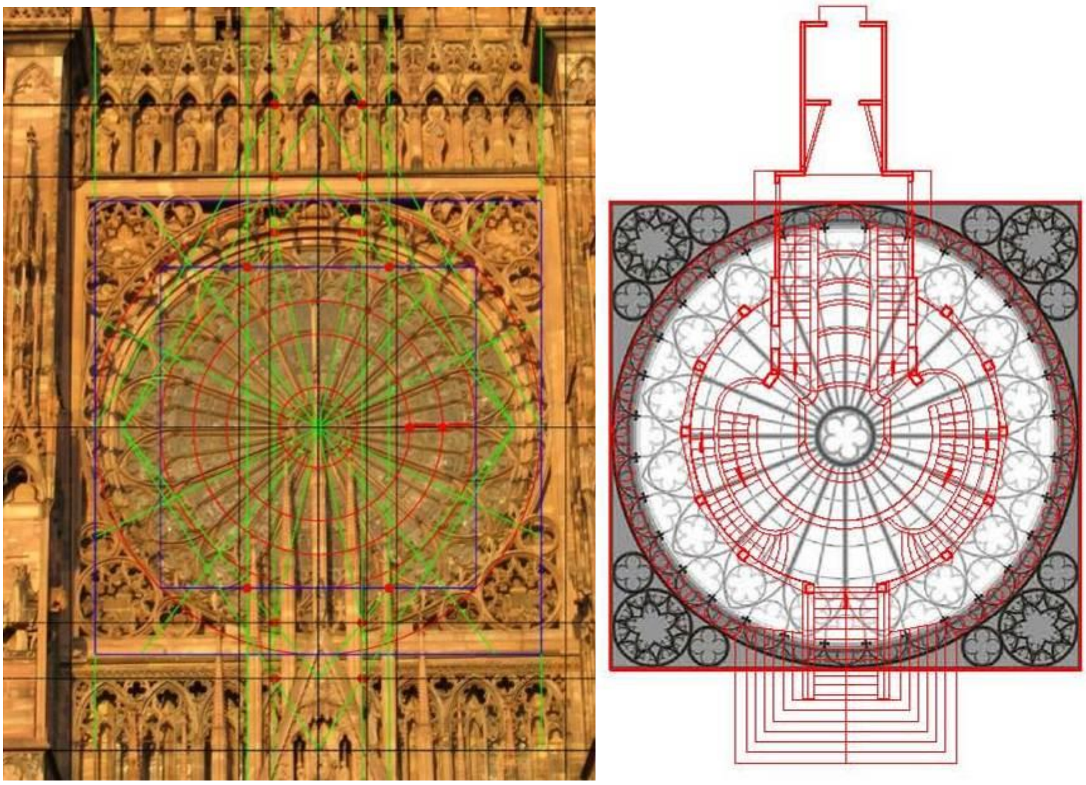


Figure 20 Overlaying the *Glashaus* plan onto Strasbourg's western façade and rose-window. (Original overlaid images: www.commons.wikimedia.org).

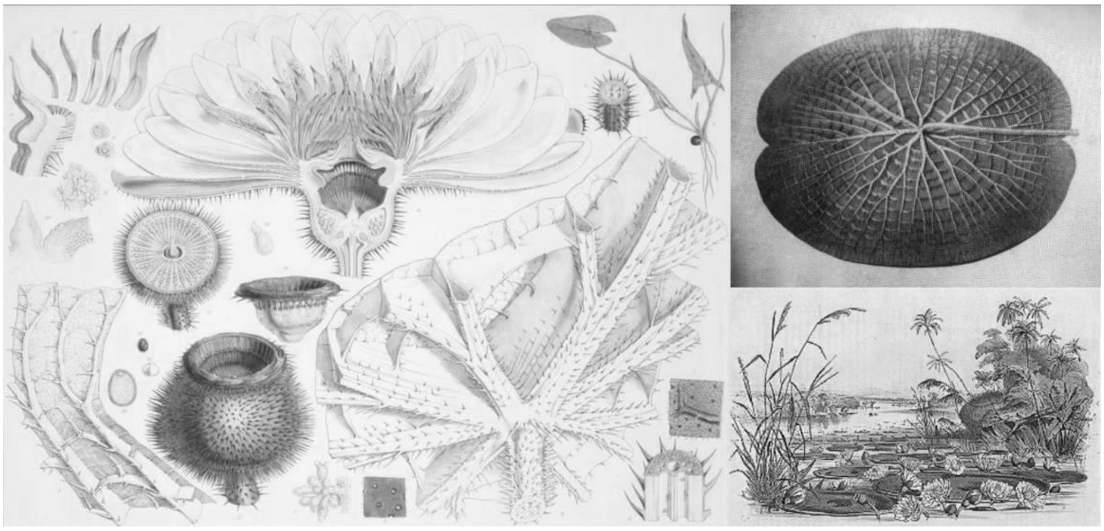


Figure 21 The *Victoria regia (amazonica)* lily (Images: www.victoria-adventure.org)**.**

architecture needs to be reconsidered because it is primarily understood from a "historicist perspective" (Ersoy, 2008 p. 8). Stemming from Alan Colquhoun (1983), the 'historicist perspective' argued that simply documenting the history of architecture according to a limited contextual understanding of objects was insufficient. Instead, Colquhoun proposed a method of history aware of preceding cultures and practices as well as how these transform both the context and the object. Instead, Ersoy followed Banham's lead and quoted some 'respectable' literary sources from which the *Glashaus* had either been totally omitted or relegated to obscurity. These sources are Arthur Korn's 1929 *Glas im Bau und als Gebrauchsgegenstand (Glass in Construction and as Commodity)* and Konrad Werner Schulze's 1929 *Glas in der Architektur der Gegenwart (Glass in Contemporary Architecture)*. Ersoy (2008) thus concurred with Banham's (1959) arguments by investigating what fictive metaphors could be attached to both Joseph Paxton's Crystal Palace and Taut's *Glashaus*. He stated that, for Paxton, it was the fictive metaphor of the table and the tablecloth, while for Taut, it was the surface and the crystal. According to Ersoy (2008), there were numerous similarities between the Crystal Palace and the *Glashaus*: both were exhibition pavilions (Crystal Palace was constructed for the Great Exhibition of 1851 in Hyde Park, London); both served the interests of the glass industries of the day; and both were designed as temporary structures. Yet, there were also differences. The main one was that that, while the Crystal Palace rose to unimaginable heights of cultural and architectural recognition, the *Glashaus* remained relatively obscure (Ersoy, 2008 p.25).

Ersoy (2008) argued that the Crystal Palace's 'atmospheric effect', which was the result of its glass cladding, was what attracted Taut to it (Taut, 1921 p. 36). For Taut (1921), glazed cladding was thus to be used as a light filter that effectively dissolved the wall with light. In his 1921 article, "Das Bauen mit Glas" ("Building with Glass"), Taut argued that the iron and steel train stations, factories, and exhibition-hall structures of the 19th century challenged both the fundamental and traditional definition of rooms (space surrounded by solid walls), which were based on the laws of gravity. For Taut, iron and steel construction reinvigorated the Gothic way of enclosing space. Once again, glass was used as the enclosing element. He noticed that the 19th century structures, while very appealing in their atmospheric effect from a distance, were less appealing at close range. The iron skeleton was thus a massive improvement as a means of enclosing space. However, the main problem was the glass or sheet panels that in-filled the spaces between the iron structural elements. Taut proposed that architects should rather treat the glass cladding as expressive of the materials' "…outstanding conditionality…", thereby expressing more sensitivity to the world outside through its dealing with light and air (Taut, 1921 p. 37)**.**

Taut may have been introduced to the Crystal Palace via Hermann Muthesius' 1902 work, *Stilarchitektur und Baukunst.* Muthesius was the German cultural attaché to London and spent several years there observing the results of English industrialisation. Muthesius is credited with shaping both the theoretical framework for and being the founding figure of the German *Werkbund*, which he achieved primarily through two seminal works – the aforementioned *Stilarchitektur und Baukunst* (1902) and his subsequent 1904 three-volume work *Das Englishe Haus (The English House)* (Maciuika, 2005). Taut, through his involvements with the *Werkbund,* must have known of Muthesius and his publications.

In a discussion on the formative origins of the Crystal Palace, Ersoy (2008) discussed Joseph Paxton's earlier horticultural experiences with the cultivation of the *Victoria regia* lily (Figure 21). Furthermore, Ersoy (2008) argued that this lily was the initial impetus for Paxton's subsequent buildings. Interestingly, Taut in his 1920 work “Die Galoschen des Glucks” (“The Lucky Shoes”) specifically mentioned the *Victoria regia*, while his “Die Grosse Blume” (“The Big Flower”) image, which

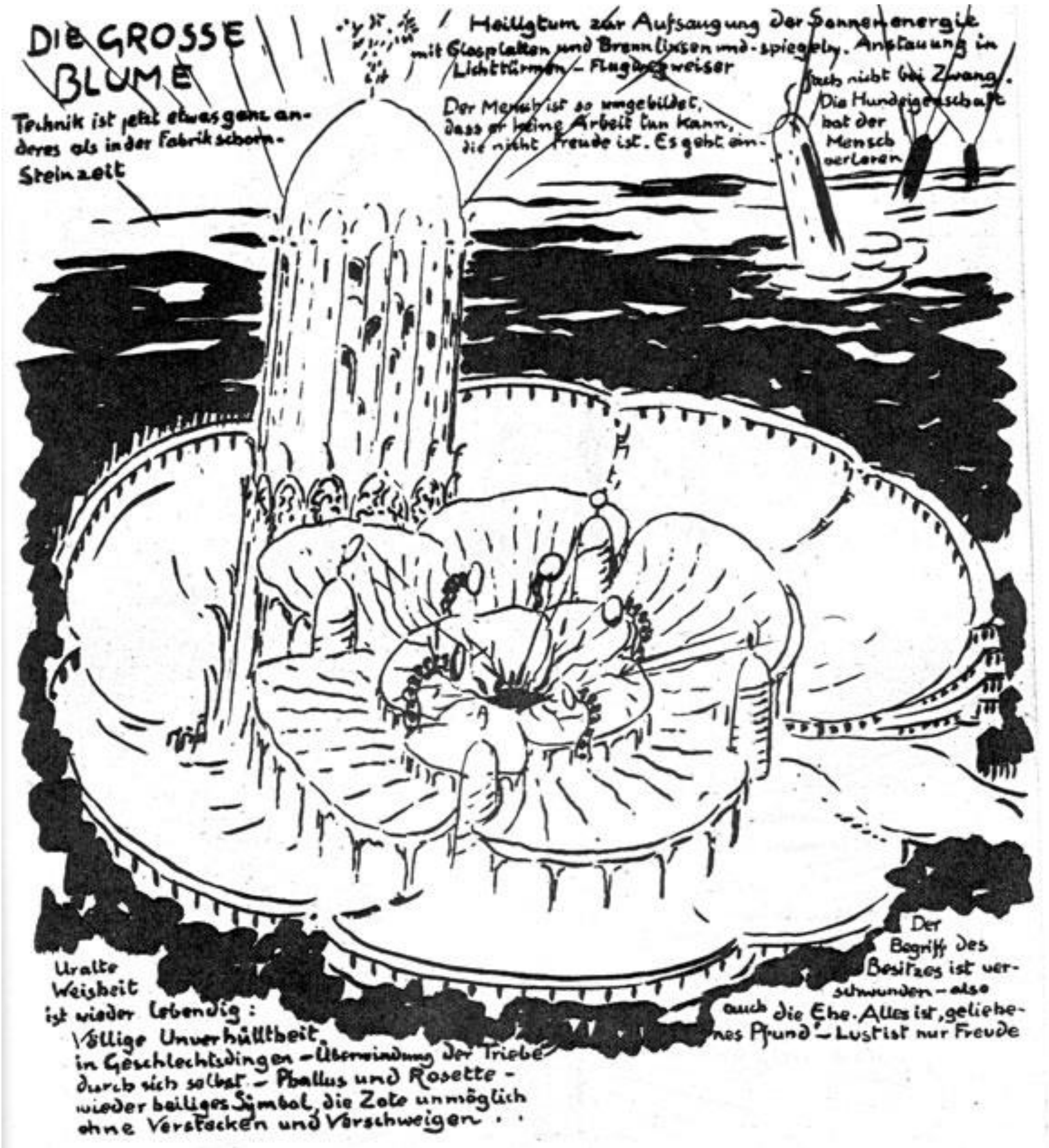


Figure 22 Bruno Taut’s illustration “Die Grosse Blume” (Image: Taut, 1920).

appeared in his 1920 work *Die Auflösung der Städte* also looked remarkably similar to the leaf of the *Victoria regia* (Figure 22). A closer examination of “Die Galoschen des Glucks” reveals remarkable affinities between Taut’s thinking, the *Glashaus* and the *Victoria regia.*

2.8 Bruno Taut and “Die Galoschen des Glucks”

Translated into English by Iain Boyd Whyte (1985) , “Die Galoschen des Glucks*”* formed part of a set of correspondences, called the Crystal Chain Letters, between Taut and a select group of his peers. This correspondence took place in the period during and immediately after World War One, a time when German architects were forced to pursue other interests, such as writing, instead of building, owing to the poor economic situation. Dennis Sharp (1966) referred to the Crystal Chain Letters as having been the most important exchange of theoretical architectural ideas of the 20th century.

Taut began "Die Galoschen des Glucks" by emphatically stating that its intention was to show, in a tangible manner, the ideas that inspired the group. Taut continued by stating that he had included parts in the script reflective of the particular thinking of other members of the group: "metamorphosis" for Herman Finsterlin; a "radiant cathedral" for Carl Kram; and a "flame building" for Wilhelm Bruckmann (Whyte & Taut, 1985).

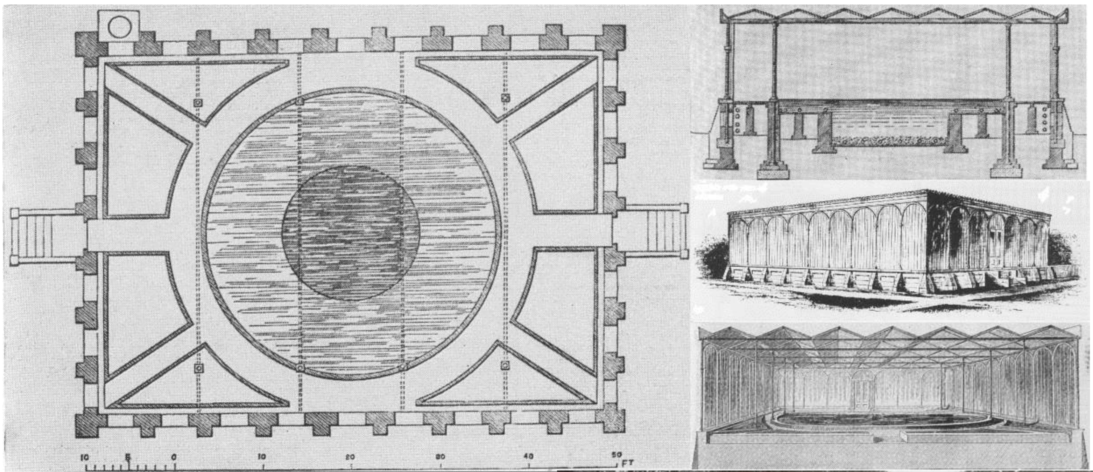
The script proper started with the description of a desolate unemployed youth accompanied by a 'hollow-cheeked girl' in the context of a blighted urban industrial landscape. In an attempt to escape this environment, the youth decided to relocate to the countryside. On his arduous journey out of the city, along an endless desolate highway, the youth encountered the 'Shoes of Fortune', which had been left on the road-side by the 'Child of Fortune'. After the youth tried these shoes on, everything changed; his current clothes, which were mere rags, became splendid garments, and the road once desolate and blighted was lined with trees that were bathed in bright sunshine and fresh air. Reinvigorated, the youth continued along the transformed highway and entered a wooded area, in which he discovered a clearing. Located at the edge of this clearing, surrounded by glittering, sparkling trees, was a gleaming building. This building appeared to be both man-made and the product of nature – like trees, springs, and all creation and that grew. Standing in front of the building, the youth clapped his hands in amazement. The house opened and a man stepped out to greet him. The man was described as bearded, handsome and dressed in a similar manner as the youth. The man then invited the youth into the building that was occupied by family, hospitality and purity, and decorated with flowering growths of stone and glass. The man then led the youth upward into a room of glass, where he pointed outward to the glittering woods. When the man's wife entered the room, her features reminded the youth of a previous association, and the youth then started to cry. In an attempt to console the youth, the man then led him in a wondrous chamber that contained "…many strange growths, great floating leaves (like *Victoria regia*) and many others" (Whyte & Taut, 1985 p.120)**.** The man then took a peculiar rod and stimulated the growths with its point,

> …and out of the leaves grow houses… as sparkling and dreamlike as his own, like opalescent domes, butterfly-wing buildings – oh, inexpressible – a fairy-tale city reflected in the water, ravishingly beautiful (Whyte & Taut, 1985 p.120).

Overpowered, the youth then lost consciousness and later awoke, once again on the initial bleak, desolate highway.

Before continuing further with this script, it would be appropriate to offer some interpretation and contextualisation. The youth could represent Taut. In an attempt to mediate or mitigate the worst effects of industrialisation, Taut, through his actual interests in urban planning issues and particularly his involvement with the German Garden City Movement, sought the reintroduction of 'nature' into cities. The journey out of the city could be argued as synonymous with this quest. The script started in an industrial, rapidly urbanising city, which is undoubtedly German and possibly Berlin. The script makes particular mention of a blighted urban environment and that it contained *Mietskasernen,* which were the dreary and crowded tenement houses common to German cities of the time. The *Mietskasernen* can thus be proposed as the metaphor for the polluted, overcrowded industrial city. The 'Shoes of Fortune' and the 'Child of Fortune' thus envisage a better future for mankind in the industrial, German city. Alternatively, they could be representative of the knowledge or ideas being proposed by Taut and his peers to achieve the transformation of the German, industrial city. The discovery of the growing house in the woods could be indicative of many things, but is undoubtedly connected to Taut's conception of his new glass architecture, as embodied in his earlier *Glashaus*. For Taut, in conjunction with Garden City ideas, the architectural elements that represented the reintroduction of 'nature' into the industrial city could be botanical glasshouses, or even the glazed public Winter Gardens and *Floras*.

In *Glasarchitektur* (1914), Scheerbart made particular mention of the glasshouses at the Royal Botanical Gardens in the Berlin suburb of Dahlem. Scheerbart was also apparently instrumental in introducing Taut to horticultural glasshouses. As such, the man in the story who greeted the youth could be proposed as representing Scheerbart. By guiding the youth through the growing house, Scheerbart thus 'introduces' Taut to glasshouses. The sparkling and flashing woods that surrounded the growing house are likely connected with Taut's earlier exposures of opinions concerning the 'atmospheric effect'. The argument that the growing house is Taut's own new glass architecture, as personified in his *Glashaus,* is further reinforced by the description of the growing house that the youth enters. It referred to the youth and man that entered a 'room of glass'; this is distinctly similar to the *Glashaus* where the visitor entered and then proceeded upward, via the semi-circular staircases to the Cupola Room. Once in the room, the man pointed outward to the 'glittering treetops' – this is once again distinctly similar to the 'atmospheric effect' created for the visitor by the Cupola Room's glazed skin of coloured glass and Luxfer prism tiles. Alternatively, it could also be the experience



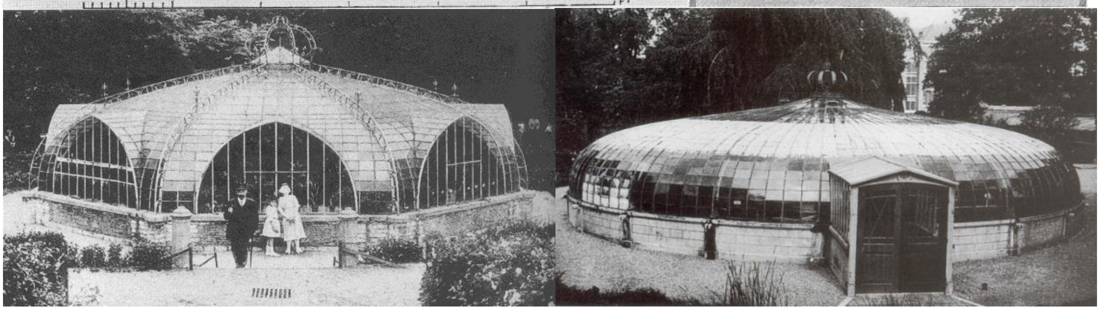
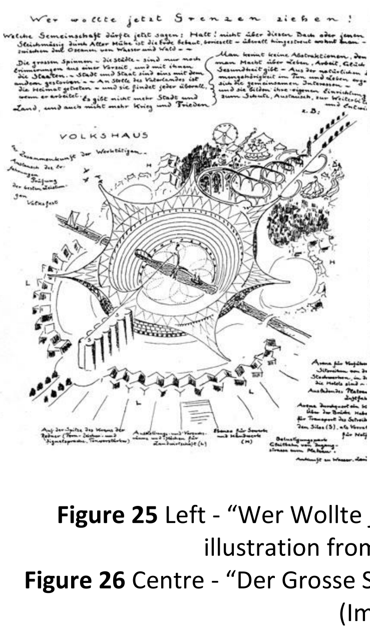


Figure 23 Top - Joseph Paxton's 1850 *Victoria regia* glasshouse (Image: Chadwick 1961).
Figure 24 Bottom left - Post-1860 *Victoria regia* glasshouses of Continental Europe. Left bottom - An 1854 example by Alphonse Balat. Bottom right - an 1870 example at Leyden University (Images: Hix, 2005).

of the route of the upward staircase, lined with clear glass bricks, once again creating the desired ‘atmospheric effect’. It could thus be argued that the sparkling, glittering or gleaming trees, bushes, and nature in general were metaphors for Taut’s desired ‘atmospheric effect’.

The building or ‘apartment’ that they then entered, with its hospitality, family and ‘blossoming growths of stone and glass’, could be presented as a Gothic Cathedral. On 28 January 1920, Taut wrote a short note to the Crystal Chain group: “Tonight I went up the tower of the Strasbourg *Minster*, through all kinds of scenery, cried with delight, and came to a wood, where houses grew on the trees instead of leaves” (Whyte & Taut, 1985 p. 46). Strasbourg Cathedral has an ‘openwork’ spire above its north-western corner. ‘Openwork’ is a technical term that refers to the spire structure having no infill or cladding material. Both Taut’s (1985) letter and the openwork spire of Strasbourg Cathedral sound distinctly similar to both the growing house in the clearing in the forest and also the *Glashaus*’ rhomboid reinforced concrete dome structure.

Based on Taut’s (1920b) reference to the *Victoria regia* lily, the second room into which the man led the youth, in an attempt to console him, is in all probability a metaphor for a type of glasshouse intended for aquatic plants. Interestingly, after Paxton cultivated the *Victoria regia* in Britain for the first time in 1849, he built the lily a dedicated glasshouse the following year (Figure 22). Paxton’s *Victoria regia*



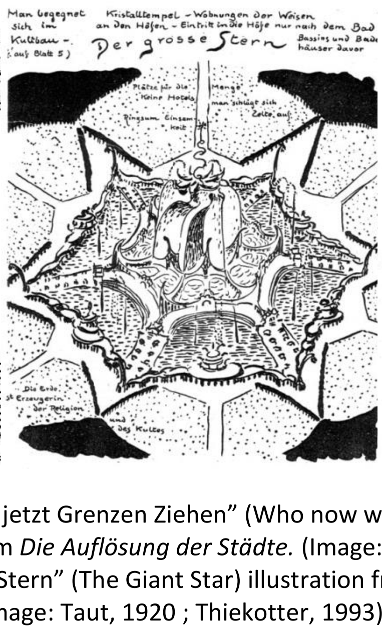


Figure 25 Left - “Wer Wollte jetzt Grenzen Ziehen” (Who now wanted to draw boundaries) illustration from *Die Auflösung der Städte.* (Image: Taut, 1920).
Figure 26 Centre - “Der Grosse Stern” (The Giant Star) illustration from *Die Auflösung der Städte.* (Image: Taut, 1920 ; Thiekotter, 1993).
Figure 27 Right - “Heiligtum der Glühenden” (Glowing Sanctuary) illustration from *Die Auflösung der Städte*. (Image: Taut, 1920).

house was basically a regular cube of glazing that was raised above a low stone plinth. Its interior had a large circular pool that was located at the centre of the plan for the lily (Chadwick, 1961). With the subsequent spread of *Victoria regia* cultivation to continental Europe, further unique glasshouses were developed that differed from Paxton's prototype by having a circular or regular polygonal plan with a flattish glazed dome (Kohlmaier & von Sartory, 1986) (Figure 23). These European examples of *Victoria regia* glasshouses were, however, similar to Paxton's prototype in that they had a central pool and low stone or masonry plinth. A comparison between these continental European *Victoria regia* glasshouses and Taut's *Glashaus* reveals immediate similarities in both planning and appearance.

The connection between "Die Galoschen des Glucks" and the *Glashaus* is further strengthened by what Taut (1920b) wrote in the script regarding the man agitating leaves with a peculiar rod. The rod in the script could be directly synonymous with the central light feature that was present in the *Glashaus'* Cupola Room*.* Furthermore, the agitated leaves could be the central *oculus*, or pool, that connected the lower Cascade Room to the Copula Room above. However, this sequence could also have been a direct reference to the inspiration that Paxton derived from the *Victoria regia*'s leaf for the design of his 1850 glasshouse. In an article published in the *Illustrated London News*, Paxton (1850) admitted that the origin of Crystal Palace derived from his gardening experiences, particularly from the glasshouse that he built for the *Victoria regia*. He even went so far as to concede: "…to this plant and to this circumstance that the Crystal Palace owes its direct origin" (Fay, 1951 p. 11).

Taut's statements in the script directly referring to the *Victoria regia* suggest it may have been an important source of inspiration for the *Glashaus*: "… and out of the leaves grow houses … as sparkling and dreamlike as his own, like opalescent domes, butterfly-wing buildings – oh, inexpressible – a fairy-tale city reflected in the water, ravishingly beautiful" (Whyte & Taut, 1985 p.120). The "fairy-tale city reflected in the water" could well be Taut's "Die Grosse Blume" illustration as it appeared in *Die Auflösung der Städte.* The script abruptly concluded this portion by leaving the youth once again on the bleak, desolate highway. This passage seems to suggest the period in Taut's life after the both the *Glashaus* and the outbreak of World War One.

Taut's "Die Galoschen des Glucks" script continued with the youth once again waking up on the desolate highway. Running after the youth was the 'hollow-cheeked girl', who is approached by the 'Child of Fortune' and offered various 'Shoes of Fortune'. The girl tried on a pair of shoes that were different from the youth's, and once again the desolate highway and the girl were transformed; the context changed to a summer night with blossoming bushes next to the road. The sky was likewise filled with meteors and twinkling stars, with the girl, in light clothing, barefoot and with loose flowing hair, running happily along the road. The girl was then joined by numerous other 'happy people' and they proceeded toward a 'city of flames'. In the 'city of flames', all the buildings appeared to be glowing, with some being incandescent, and it was impossible to tell if the buildings were actually built from flames. The group of 'happy people' then entered an incandescent house, and a lively display of sparks and fire, a cascade of water and a 'fire-bathing party' ensued. Gradually, the bright fiery display diminished until there was only a faint sparkle left. The girl then finally sank to the floor, but she could not sleep. The girl then looked at the faint sparkle playing high up in the room, and saw the face of her 'loved one'. Distraught and emotional, the girl then started to weep and was comforted back to sleep by the 'Child of Fortune', who then left a pair of luck shoes that were the same as the youth's. When the girl awoke in the morning, she was amazed to find herself in a 'sparkling, dew-fresh' garden in front of the house that the youth initially entered. The house opened and a woman and child emerged, followed later by the youth and the bearded man. The youth and girl were in a state of bliss, staring at the house in amazement before continuing their journey.

It would appear as if this portion of the script was included for Wilhelm Bruckmann, but was also overlaid with some thoughts of Taut's *Glashaus*, in the form of the 'incandescent house', 'cascade of water', and the 'fiery sparkle high up in the room'. Furthermore, the perspective is not that of Taut in the character of the youth, but from another unidentified personality in the form of the 'hollow-cheeked girl'.

The script continued with the youth and girl approaching a high plateau, with buildings being seen in the distance. These shining 'crystalline' buildings, seen from a distance, were scattered enchantingly, and sparkled delightfully, in the landscape. The youth and girl were drawn towards the buildings and, suddenly, a landing airship appeared. The youth and girl boarded the airship and they soared above the earth. While on the airship, the couple experienced a 'radiant vision' that comprised a view of all of the crystalline buildings from a perspective that was below the clouds, both near and far. These experiences of crystalline building in the landscape are apparently illustrated in *Die Auflösung der Städte* (Figures 25, 26 and 27).

The couple then landed and joined a ceremonial procession, which then turned off a road and led toward a 'radiant cathedral'. Stopping at the doorway of the cathedral, the couple were overpowered by a 'display of ecstasy'. An older gentleman, apparently a priest, approached the couple and led them into the cathedral's library. Inside, the youth took down a book that detailed men not waging war, but 'building in the Alps'; the girl also took a book, but hers detailed

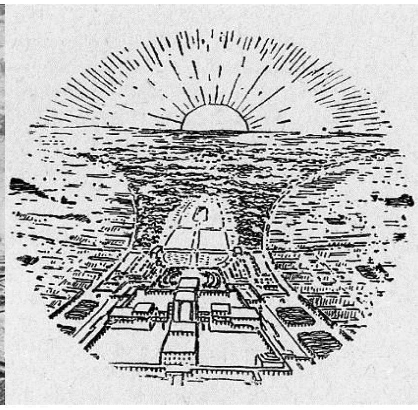


Figure 28 Left - A medieval view of Strasbourg Cathedral from *Die Stadtkrone.* (Image: Taut, 1919b).
Figure 29 Right - A westward aerial view of Taut's proposal for an ideal city from *Die Stadtkrone* (Image: Taut, 1919b).

nothing but misery, which included the trenches of World War One and the *Mietskasernen*. Finally, the couple saw their own families in a wretched slum, with appalling living conditions, and they started to cry inconsolably. Departing from the 'radiant cathedral', the couple then saw a distorted disturbing image of the cathedral being overpowered by a vision of the *Mietskasernen.* Fleeing these disturbing and 'exotic' surroundings, the couple then ran through a wood and arrived, exhausted, at a 'deeply set spring under a dark roof of trees'. Here they drank, and fell asleep on moss as evening faded to night.

It would appear that this portion of "Die Galoschen des Glucks" was written for Carl Kram (and Taut himself stated that the 'radiant cathedral' was intended for Kram). It could also be proposed that some of Taut's ideas are clearly evident. The images of men 'rebuilding the Alps' and those from the airship are likely to be the same images found in Taut's *Alpine Architektur* of 1919. The idea of the cathedral being the central nodal focus of European medieval cities, which was then 'overpowered' by the sprawling *Mietskasernen* of the modern industrial city, is distinctly reminiscent of Taut's *Die Stadtkrone* also of 1919, in which Taut argued that this lack of a central focal feature in the industrial city was like a 'torso without a head'. Furthermore, it is also highly likely that this section of the script was a reiteration of the first section: in both instances, the youth and the girl fled the worst excesses of the German industrial city, as personified in the *Mietskasernen*. Likewise, in both cases, they fled through a forest and ultimately arrived at a location that was the *Glashaus*. In the first instance, they arrived in the glazed upper portions of the *Glashaus*, while in this instance, they arrived in the Cascade Room with its kaleidoscope. As stated above, the kaleidoscope room or passage of the *Glashaus* was also clad in violet-coloured velvet. This velvet could be comparable to the moss upon which the couple fell asleep. The spring that they drank from could be the waterfall that was located in the Cascade Room. The 'dark roof of trees' that covered both the sleeping couple and the spring, could have been the Cascade Room that was mostly clad with glazed tiles. However, the argument that best supports the contention that this portion of the script relates to a description of the *Glashaus'* Cascade Room is given by Taut himself in his publication *Die Weltbaumeister* (*The Global Master Builder*, or, *Global Architect*). On Plate 17 of Die *Weltbaumeister*, Taut wrote: "The empty space is purple – green leaf shapes and flowers float from the top and down the sides" (Taut, 1920a p. 17). Thiekotter (1993), in turn, linked this sentence to the *Glashaus'* Cascade Room, specifically to a Jan Mutzenbecher glass panel that was located in the glazed, semi-circular wall at the top of the Cascade Room.

The script of “Die Galoschen des Glucks” continued: darkness then enveloped the sleeping youth and girl. All of a sudden, glow-worms appeared and when viewed from above, these were “…illuminated glass domes. One unfolds and turns into an architectural flower, with a moving light at its base. We seem to fly inside. At the bottom of the flower, the shoe library of the Child of Fortune” (Whyte & Taut, 1985 p.122). The Child of Fortune was surrounded by compartments that were box-like, with each containing a specific pair of shoes of fortune. Located on a glass table in the middle of this shoe room were the shoes that the couple had worn. These shoes were then placed in a container. The Child of Fortune took from a container two pairs of wooden clogs, which were apparently from a bygone age. With these clogs in hand, the Child of Fortune flew out of his ‘blossoming house’ and placed the clogs besides the sleeping couple in the ‘grotto’. When the couple awoke, they were overjoyed to see the clogs. Having tried the clogs on, the couple was then transformed into ‘young country-folk’, ‘returning from the fields.’ The couple then returned to a farmhouse that was bright and new, quite unlike the boorish, stuffy farm of the past. Parents and children greeted each other and the setting sun shone through the farmstead window, reminding the couple of the many strange things that they had experienced. A ‘happy meal’ then ensued in a garden under the leaf cloak of a tree.

2.9 Bruno Taut and the *Victoria regia* lily

In the last portion of “Die Galoschen des Glucks” there is another uncanny connection to the *Victoria regia* lily. Along with certain other members of the families *Nymphaeaceae* and *Araceae, Victoria regia* (today called *Victoria amazonica)* is pollinated by a specific genus of *Cyclocephala* scarab beetle. Both the

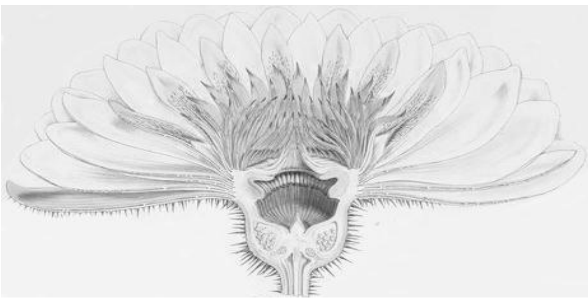
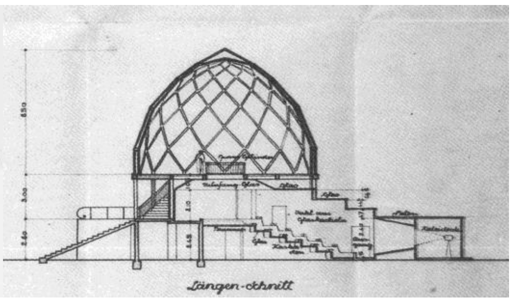



Figure 30 Left - A section through the flower of the *Victoria regia* (Image: Fitch, 1851).
Figure 31 Right - A section through the *Glashaus* (Image: Taut, 1914b).

Cyclocephala beetles and Neotropical *Nymphaeaceae* have thus co-evolved. Currently, there are four known species of *Cyclocephala* involved in the pollination of Neotropical *Nymphaeaceae* (Prance, 1980). While this fact in isolation might be nothing more than interesting, the term glow-worm as referenced by Taut "…is used in connection with the flightless females of *lampyrid* fireflies..." (Meyer-Rochow, 2007 p.251). Considering that Taut in all probability wrote his script in a European context, it could be that he is referencing a European species of glow-worm. The common European glow-worm, or *Lampyris noctiluca*, has an extensive distribution, ranging from Portugal to China (Tyler, 1986), and, according to Day (2005) this distribution probably makes it the most studied of all the *Lampyridae*. Thus, could Taut have been referencing the *Lampyris noctiluca*, which belong to the order *Coleoptera,* and are actually classified as beetles and not 'worms'? This confusion with 'worm' might arise since certain adult female *Lampyridae* resemble worms in appearance but are in fact flightless adult laviform females, which have the same appearance as larvae but with compound eyes. According to Sala-Newby et al. (1996)**,** the colours emitted from luminous beetles range through green, yellow, orange and red. However, *Lampyris noctiluca* emits a light that is apparently green during all stages of its life. As previously mentioned the colours of the *Glashaus*' dome began at the base in deep blue and progressed upward through moss-green, then golden yellow and eventually culminated at the apex in brilliant creamy white. Apart from the blue, these colours are not that dissimilar to those emitted by the so-called 'luminous' beetles. This poses the question: did Taut's choice of colours for the *Glashaus'* dome derive from the colours emitted by these beetles? Taut (1920b) stated that his glow-worms seen from above are 'glass domes', which, when unfurled, became an 'architectural flower'. Thiekotter (1993) argued that in bad weather, the reflecting glazed facets of the *Glashaus*' dome assumed a greenish-yellow colour, which resulted in the visiting public naming the building 'Asparagus-head'. Alternatively, when approached from a distance, the *Glashaus* supposedly looked like a sprouting seed or a flower bud that was about to bloom. Thus, the association of the *Glashaus* with botanical metaphors is not an entirely unique concept. However, this does not answer the question as to why Taut would refer to an ‘architectural flower’ as opposed to just mentioning it as a ‘flower’.

In 1849, the English botanist Robert Spruce described the underside of the leaf of *Victoria regia* as suggestive of some “…strange fabric of cast iron, just taken from the furnace, – its ruddy colour, and the enormous ribs with which it is strengthened increasing the similarity” (Allen, 1854 p.6). According to another description*,* when a new leaf of the *Victoria regia* first broke the surface of the water, it was initially an inverted red-brown mass covered in spines that slowly unfurled to reveal an upper smooth green surface, with a prominent upturned rim. The red-brown or deep purple underside of the leaf consisted of a prominent lattice or structure of air-filled members. Eight primary members radiated from a central stem point, which then subdivided into numerous smaller radial members. Perpendicular to these main radial members were concentrically arranged struts that divided the lower surface of the leaf into quadrangular chambers. Covering all these structural members were prominent spines (Moore & Ayres, 1850). Taking this description into account, as well as Taut’s (1921) views on the iron skeletal structures of 19th century Europe, and Joseph Paxton’s connection to the *Victoria regia*, it becomes probable that Taut’s ‘architectural flower’ had a direct link with *Victoria regia*. The contrast between the highly textured red-brown or deep purple undersides of the leaf with the smooth green upper surface is also highly indicative of the *Glashaus*’ purple-velvet-lined kaleidoscope enclosure and glazed Dome Room, which included moss green.

What is remarkable about *Victoria regia* is its sheer size, rapid growth patterns and intriguing pollination habits. The first European to discover *Victoria regia*, Thaddäus Haeneke, is said to have fallen to his knees in admiration at the first sight of *Victoria regia* in flower. French naturalist Alcide d’Orbigny described the *Victoria regia* as having been, without a shadow of doubt, the most exquisite plant ever known to Europeans because of its overall composition of leaves, flowers, size, colour and elegant location in the water. This sentiment was later also shared by Robert Schomburgk, when he, in 1842, encountered the *Victoria regia* in South America. Schomburgk described *Victoria regia* as having been one of the grandest productions of the botanic kingdom, owing to the superior magnificence of it leaves and the splendour of its flowers with their associated fragrance (Allen, 1854). Another description stated that when the flower of *Victoria regia* first broke the surface of the water, it was initially as a pear-shaped bud furnished with a dark brown, protective cover. This bud, like the underside of the leaf, was also covered by protective spines. When the bud bloomed, it was initially a brilliant white colour. Since the flowering of *Victoria regia* is nocturnal, the flowers were described as having first opened at about five o'clock in the evening, and having been approximately 25 to 38 centimetres in diameter when fully unfurled (Moore & Ayres, 1850). Furthermore, the flower was described as having been strongly pineapple scented, and, as the *Victoria regia* bloomed, the flower raised its internal temperature through a thermo-chemical reaction (Schrader, 2008). This pineapple scent then attracted the scarab beetles that pollinated the flower. The flower was recorded as having closed on the morning of the second day. By closing, the flower is said to have captured numerous beetles that were still actively pollinating it. On the second evening, the flower once again opened and subsequently released the captive beetles. The flower was transformed from its initial brilliant white into a pinkish, rose colour. At about 11 o'clock on the second night, the flower then closed permanently and sank below the surface of the water to develop its seeds (Moore & Ayres, 1850).

What is most interesting when comparing the flower of the *Victoria regia* and "Die Galoschen des Glucks" are the references to 'flying inside' and then 'the bottom of the 'architectural flower'. A comparison between a cross-section of the *Glashaus* and the *Victoria regia* flower reveals numerous similarities: they both have distinct brighter upper and darker lower portions; the upper portion, or Cupola/Dome Room, of the *Glashaus* can be compared to the petals of the *Victoria regia* flower, while the lower Cascade Room of the *Glashaus* can be compared to the lower ovary area of the *Victoria regia* (Figures 30 and 31).

2.10 Conclusion

This literature review has established that the accepted history of the *Glashaus* is problematic for three main reasons. First, there is a historical record that relies too directly on the perspective of Adolf Behne. Second, Paul Scheerbart's well-documented role in the design of the *Glashaus* appears to have been overstated. Third, Taut's thoughts seem to have been overlooked. The implications of this problematic reception are significant in that there are numerous gaps in the origins of the *Glashaus*. In starting to address these gaps, Banham's (1959) contributions are extremely important. The first of these suggests the potential for considering overlooked personalities, myths, and symbols; the second pivots on the fact that the *Glashaus* was unlike any of Taut's buildings prior to 1914; and the third entails the wider historical context of the *Glashaus*.

The alternative explanation to be offered here proposes different origins for the design of the *Glashaus*: the first derives from horticultural glasshouses and the inspiration of the *Victoria regia* lily; the second originates with the Gothic architectural style and Strasbourg Cathedral; while the third relates to the consideration of the construction techniques and technologies used for the *Glashaus.* These technologies and techniques are closely connected to the *Glashaus'* client, the *Deutsche Luxfer Prismen Syndikat.* This PhD study contributes to the knowledge of Taut's seminal *Glashaus* by offering a detailed explanation of their impact in the chapters that follow.

Chapter 3: *Victoria regia's* bequest to modern architecture

3.1 Introduction

This chapter details the numerous, diverse intentions embodied in glasshouses. This discussion is relevant as the aesthetics and planning of the *Glashaus* had an uncanny resemblance to certain botanical glasshouses. As an artefact of the 19th century, the glasshouse personified and embellished humanity's desire to dominate and control nature. Contained within an iron frame and glazed skin, these artificial environments made possible the cultivation, study and exploitation of exotic and fascinating flora—sometimes even fauna—from all over the globe. Within them, people could exercise scientific control over natural processes. Put alternatively, the historical evolution of glasshouse was driven by a desire to nurture and protect exotic plants in a controlled environment (Hix, 2005).

Glasshouses always carried complex connotations. Many feared that rapid industrialisation and the colonial practices of European nations were leading to the destruction of nature. Glasshouses were thus seen as sanctuaries for preserving nature, and fulfilled a role not unlike the museum. This was particularly evident in rapidly developing urban centres. Furthermore, because of the enormous expense required in their operation and maintenance, glasshouses were also seen as objects of social prestige. The possession of a glasshouse, like the ownership of a fine art collection, embodied gentlemanly refinement, sophistication, desire, culture and wealth. As such, the glasshouse and its contents could also be regarded as a work of art because of its skilful execution. Initially the enjoyment of nature-as-a-form-of-art was the sole preserve of the aristocracy and the upper middle classes. With the progression of the industrial revolution and the eventual separation of work and leisure, the urban enjoyment of nature soon became a reality for the working classes. Nothing could have contrasted more with the quiet contemplation and study of the tranquil private glasshouse than the public winter gardens, in which masses of paying patrons flitted through the vegetation in search of amusement.

3.2 Horticultural glasshouses: An overview

This section gives a brief overview of the different types of glasshouses that evolved from the 18th century to the late 19th century, before discussing these typologies in detail. As a distinct building type, the glasshouse as it is known today, did not come into existence until the second half of the 19th century (Hix, 2005; Kohlmaier & von Sartory, 1986; Koppelkamm, 1981). Much confusion exists around the actual names applied to 'glasshouses'. Koppelkamm (1981) explained the function of the 'glasshouse' comprised either an orangery, greenhouse, conservatory or a winter garden.

Inspired by similar structures from 200 years previous, the first horticultural building, the orangery, was a plant house of the 18th century that housed citrus, pomegranates, myrtles, etc. during the cold winter months. The most important function of the orangery was to keep the interior temperature of the room above freezing. Generally, the orangery was constructed of brick or stone, had a solid roof and large, south-facing windows. Orangeries were often located within the precinct of castles and had an architectural style that was similar to the surrounding structures. Koppelkamm (1981) also distinguishes other structures that formed a transitional typology between the initial orangery and the later large plant house of glass and iron. These were described as having a similar outward appearance and plan as the orangery, but had glazed roofs, with a central dome rather than a flat roof, over the central portion of the building. These plant houses of iron and glass first appeared in the first half of the 19th century.

According to Koppelkamm (1981), a 'greenhouse' is apparently also known as a plant or forcing house. The function of the greenhouse was to cultivate both decorative and useful plants. These simple structures were generally purpose built and had a back wall that faced north with an attached sloping glass roof, which faced south. In cross-section, these structures were relatively narrow, while they were additionally elongated in plan. In greenhouses, plants were grown in pots, arranged on pedestals that rose like steps, and that sloped rearward towards the wall. By contrast, Koppelkamm (1981) argued, in the glasshouse or conservatory, plants did not grow in pots, but were rather placed in the ground in beds.

The name ‘glasshouse’ or ‘conservatory’ was generally applicable to structures that were used for scientific purposes and/or for the collecting of plants. These buildings were generally tall in cross-section due to the fact that they contained exotic botanic species that reached generous heights, such as bamboo, tree ferns and palms. Plants of a particular species were usually grouped together, with the higher central portion generally being used for tall species, mostly palms. Most glasshouses had a rectangular plan, similar to that of the orangery, and were constructed out of glass and iron. Unsurprisingly, in glasshouses, the glazing comprised the majority cladding material on all of the elevations (Koppelkamm, 1981).

Koppelkamm (1981) referred to ‘winter gardens’ or conservatories as having been not so much a type, but rather a function. This type of structure encompassed orangeries, transitional structures, glasshouses and conservatories. These buildings could be both private and public. Described as having been ‘ornamental and show buildings’, they were proposed as mainly having been used to add to the living spaces of residences. Possibly the most significant aspect of the winter garden was the climate; it was maintained not for the welfare of the plants, but rather for the comfort of humans (Koppelkamm, 1981).

3.3 The orangery

The orangery evolved because of the fondness the European nobility and wealthy bourgeoisie had for cultivating citrus and, much later, palms. Limes, lemons, and particularly oranges, with their beautifully fragrant fruit and flowers, fascinated the aristocracy (Hix, 2005). Koppelkamm (1981) argued that the Italian nobility were the first to be fascinated with oranges, and from there, the vogue

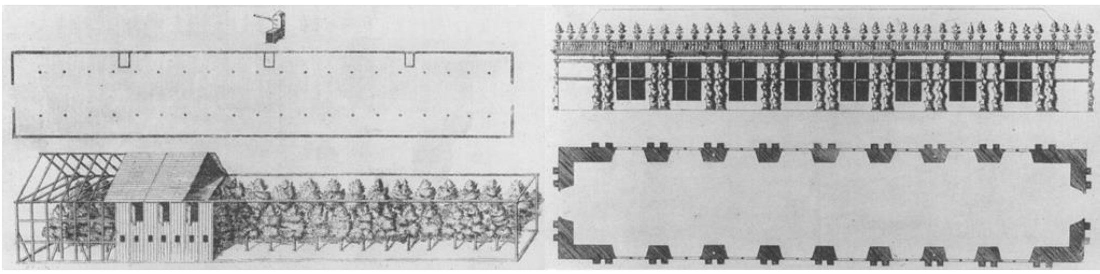


Figure 32 17th century Orangeries designed for the Elector of Palatine by Salomon de Caus (Image: Hix, 2005).

spread to the rest of Europe. Initially, individual citrus trees were planted in the ground and covered, during cooler periods of the year, with movable sheds that were made from timber boards. Kohlmaier (1986) stated that this method had been used in Germany since the middle of the 16th century, while in Italy, north of Naples, it had been in use since the renaissance (Hix, 2005). As a logical progression, whole groves of citrus trees were soon being covered by a larger, portable wooden orangery. It was at the courts of Stuttgart, Munich and Heidelberg that temporary buildings were first erected (Koppelkamm, 1981). In 1609, a portable fig house was constructed at Stuttgart, while a mobile orange house on rollers was later also constructed in 1626 (Koppelkamm, 1981). An example of such a building was the 280-foot-long structure for the Elector Palatine at Heidelberg, Germany (Hix, 2005) (Figure 32). Owing to the success of this wooden structure, the designer Salomon de Caus soon afterwards suggested that a better orangery would include permanent stone walls and only needed a roof and closed windows during winter (Hix, 2005). Hix (2005) argued that this was an early example of the European orangeries-cum-banqueting halls that were enjoyed by the aristocracy during the 17th to 19th centuries. As Kohlmaier (1986) has argued, the cost and time expenditure were significant with the portable wooden system. Koppelkamm (1981), likewise, argued that the disadvantage of these buildings was bad insulation and the need to seal all of the joints every time the structure was reassembled. This meant that citrus trees were soon surrounded by three permanent walls and only the south wall and roof were removable. However, these structures proved unsatisfactory, mainly due to the inability to sufficiently control heating during the cooler periods of the year.

Hix (2005) stated that in parallel with the temporary shed arrangement, a further method of placing citrus trees in pots and moving them into caves or stone buildings during winter was also developed. Koppelkamm (1981) proposed that initially existing structures like garden rooms, grottos or open verandas were used—a method said to have been in use as early as 1555 in France (Hix, 2005). By the 17th century, two methods of preserving plants during the colder months of the year developed; namely, moving potted trees indoors, or surrounding those planted in the ground with temporary sheds. Owing to the technical difficulties of the movable shed enclosure, the ‘permanent orangery’ soon developed. Technical difficulties were not the only aspect leading to the development of permanent orangeries; aesthetic factors were also of concern (Koppelkamm, 1981). If the unpretentious and purely functional temporary orangeries were to be integrated into the overall aesthetic of a castle, only a building of stone or masonry would suffice. Kohlmaier (1986) described the permanent orangery as elongated masonry buildings, with the south elevation being made of glass panes. The interiors of these buildings were fitted with iron stoves for heating, and care was taken in the construction of the walls and roofs to insulate against heat loss. The permanent orangery reached its peak of development during the period 1700 to 1730. Importantly, the permanent orangery was a versatile ornamental building, adaptable for other uses and functions, such as holding receptions and banquets (Koppelkamm, 1981).

3.4 The glasshouse

Around 1700, in parallel with the masonry walled, permanent orangery, the glasshouse or glazed greenhouse came into prominence (Hix, 2005; Kohlmaier & von Sartory, 1986; Koppelkamm, 1981). What differentiated a glasshouse from an orangery was the fact that, from the start, the glasshouse was purpose built for horticultural endeavour. It was not subject to the demands of any prevailing architectural style (Hix, 2005; Kohlmaier & von Sartory, 1986). Hix (2005) stated that

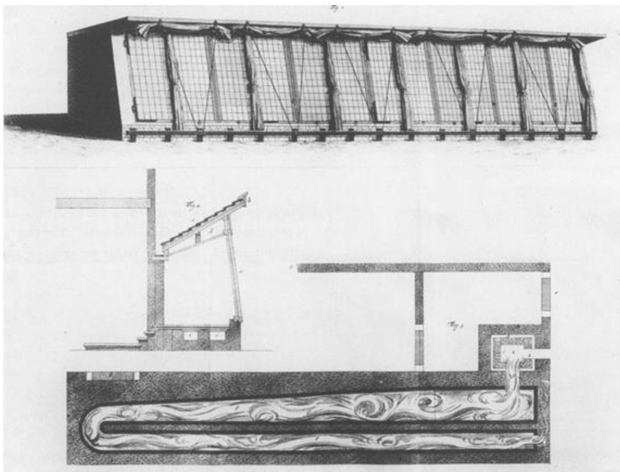
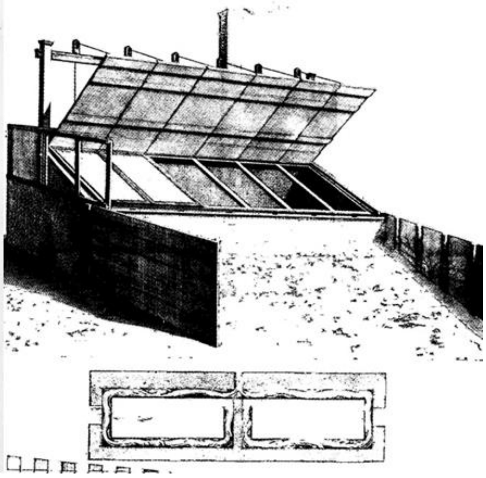



Figure 33 Left – An early example of the European ‘forcing frame’ or ‘Dutch-stove’ construction (Image: Hix, 2005).

Figure 34 Right - An example of a later optimised ‘forcing frame’ or ‘Dutch-stove’ (Image: Hix, 2005).

early examples of glasshouses were the European ‘forcing frame’ or ‘Dutch-stove’ constructions that were most prevalent in Holland (Figure 33). He further argued that if Holland was the general location of early glasshouse development, its epicentre was located at Leiden University.

Under the directorship of Herman Boerhaave during 1709 to 1730, Leiden became one of the finest horticultural locations in the world, and was termed “… an environmental machine for nurturing and producing plants” (Hix, 2005 p.20). By 1720, with improvements in glass availability and manufacturing, the most innovative glasshouses had glazing on the entire south-facing elevation and the roof (Hix, 2005). Kohlmaier (1986) stated that while these glasshouses had solid walls to the sides and rear, both the south wall and the lean-to, or ridged roofs, were glazed. Hix (2005) describes the early sloped-fronted, forcing frames as having been optimised to the often unpredictable, wet and cold weather of Holland. Hix (2005) further described these structures as having had massive masonry back walls and floors that provided a large store of thermal mass. Heated by sunlight during the day, this thermal mass then subsequently released warmth during the night. A continuous heat and smoke flue was additionally located in the back wall. The south-facing elevation contained a series of hinged panels that allowed plants to be moved in and out of the structure. In summer, the windows were opened to maximise sun penetration and ventilation. In winter, they were sealed to prevent draughts and only opened on warmer days. In some cases, these windows were opened by a top-hung frame that was operated through a system of pulleys and ropes. Additionally, these windows also had an early form of double-glazing, through the application of a film of oiled paper to the inside pane, with further canvas curtains that supplied additional insulation. The provision of adjustable wooden planks, parallel to the side walls, allowed for protection from prevailing winds (Hix, 2005) (Figure 34). After 1750, once the technical basics were established, glasshouses spread to the rest of Europe, but it was not until efficient heating was achieved, that the complete glazing of the glasshouse could be realized (Kohlmaier & von Sartory, 1986).

The onset of the industrial revolution heralded numerous significant changes for glasshouses. Technical innovations, most notably in metallurgy, steam heating and glass, enabled the scale of the glasshouse and its associated glazing to be expanded. Additionally, the focus of horticulture changed from a predominantly European focus to a wider global perspective. Expeditions to the new lands of the East and West Indies, Africa and South America returned to Europe with a bounty of palms and ferns. The palm thus became the "…love of a society weary of Europe" (Tschira, 1939 p.97). In the 19th century, palms were the so called 'prince of plants', named because of its 'noble and impressive shape', fecundity and usefulness, botanical novelty and Christian religious connotations (Kohlmaier & von Sartory, 1986). In his book *The Greenhouse, Hothouse and Stove,* Charles MacIntosh (1838), quoted the Bavarian Dr. von Martius as describing palms as the inhabitants of the 'happy countries' of the tropics. Koppelkamm (1981) stated that the palm became a symbol of the longing for these 'happy countries'. The increasingly influential middle classes, empowered by the industrial revolution, expressed their newfound wealth and culture through the acquisition and care of a palm collection (Kohlmaier & von Sartory, 1986). As a result, Kohlmaier (1986) contested, the low and narrow glasshouse then transformed into the spacious conservatory. From this point, the winter garden became an enchanting landscape "…and indeed a tropical one full of secrets." (Tschira, 1939 p.98).

The 19th century interior image of the glasshouse comprised the grouping of shrubs and trees with the inclusion of grottos, springs, fountains and water features (Kohlmaier & von Sartory, 1986). An increase in botanical studies and communication between European learned societies further assisted the rapid development of the glasshouse (Hix, 2005; Kohlmaier & von Sartory, 1986). This allowed the glasshouse to transform into a 'scientific art', constructed with ever-increasing glazing and better heating systems, which enabled the glasshouse to become popular throughout Europe and the Americas (Hix, 2005). The form and volume of the resultant 19th century glasshouses were thus generally determined by the cultivation and display of plants from the warm or tropical regions, which usually included tall trees, but with a particular focus on palms (Kohlmaier & von

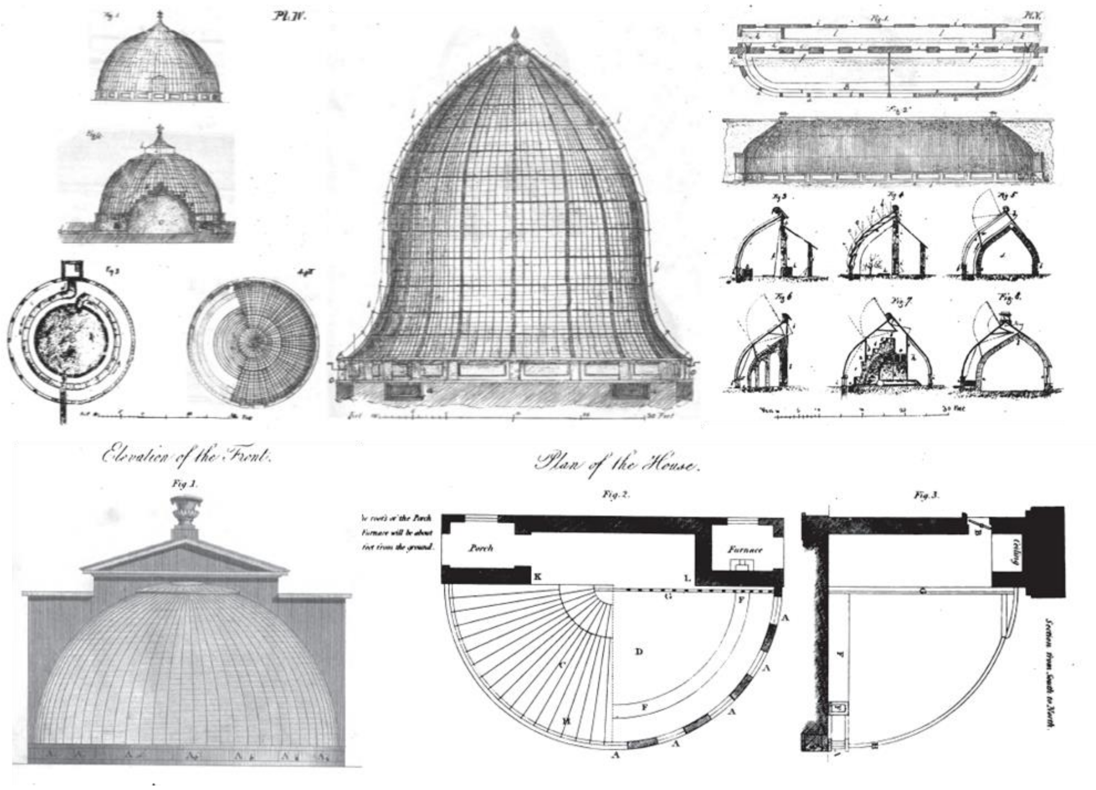


Figure 35 Top -Examples of curvilinear glasshouses proposed by J.C. Loudon (Images: Loudon, 1817).
Bottom – An example of a curvilinear glasshouses proposed by G.S. Mackenzie(Images: Mackenzie, 1815).

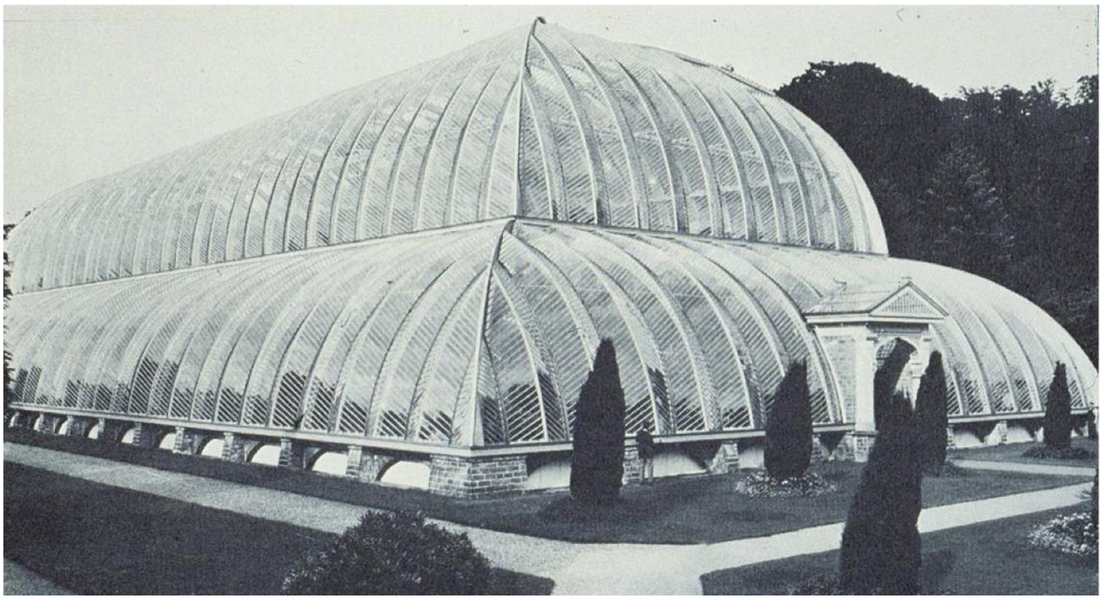


Figure 36 Joseph Paxton's Great Conservatory at Chatsworth (Image: Hix, 2005).

Sartory, 1986). Hix (2005) surmises these developments perfectly: larger glasshouses, containing an ever-increasing number of species and sizes of plants, were the result of a new logical and empirical approach derived from a new European tradition of scientific endeavour. Because of the vast improvements in artificial environmental control, these newer, larger glasshouses could let in even greater amounts of natural light. While the colonial legacy of the 18th century had brought about new wealth, patrons and plants, the emergent industrial revolution had facilitated new materials and technologies (Hix, 2005). Therefore, by the dawn of the 19th century, glasshouses/conservatories had evolved into three distinct typologies (which I will discuss in detail in subsequent sections): first, the private winter gardens of the nobility and wealthy industrialists; second, the winter gardens intended for the public; third, those structures associated with the botanical gardens (Kohlmaier & von Sartory, 1986). Additionally, the first half of the 19th century witnessed two distinct phases of glasshouse development (Koppelkamm, 1981). The first phase began around 1815, with the curvilinear, façade glasshouses of J.C. Loudon and G.S. Mackenzie (Figure 35), and ended with Paxton's Great Conservatory at Chatsworth (Figure 36). Most of the examples of this phase had simple rectangular, elliptical or circular plans and were of modest scale. The second phase began in the 1840s, and comprised large-scale public buildings that had more complicated plans and were composed of several interconnected structures of varying scale. This phase is important because of the abandonment of any traditional architectural ideals; in these structures, the materials, structure and function became the architectural language (Koppelkamm, 1981).

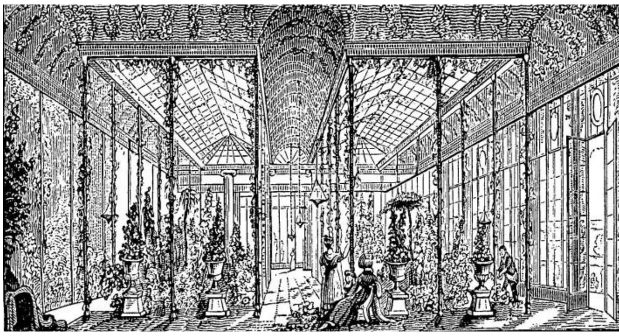



Figure 37 Left - Conservatory additions to The Grange manor house in Hampshire, England (Image: Kohlmaier & von Sartory, 1986).
Figure 38 Right – The Indian Villa adjoining Sezincote House, Gloucestershire, England (Image: Hix, 2005).

3.5 Private winter gardens

Early private winter gardens were direct additions to residences; they were joined through the 'open rooms', such as the billiards room, salon or library. Examples of these early private winter gardens were the 1823 conservatory

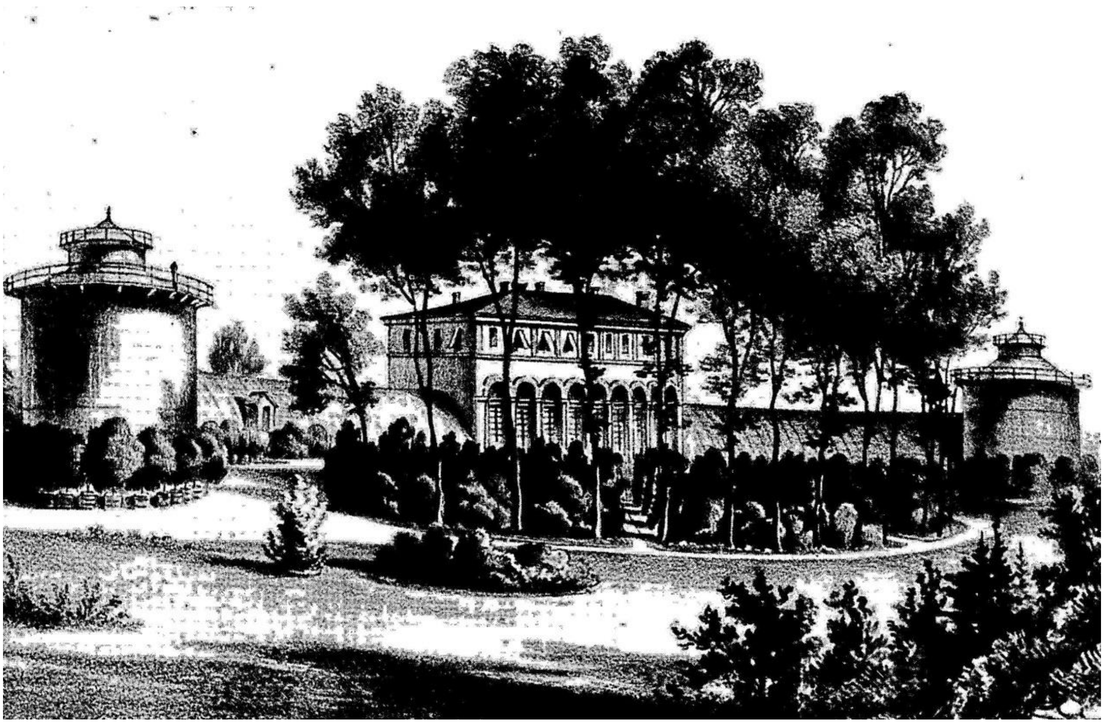


Figure 39 Villa Berg Conservatory, Stuttgart, Germany (Image: Kohlmaier & von Sartory, 1986).

additions to the Grange manor house in Hampshire (Figures 37), England, and the winter garden that was built at the Berlin palace for crown Prince Albrecht (Kohlmaier & von Sartory, 1986). However, these early private winter gardens had an outward appearance not unlike the orangery; i.e. they followed the stylistic dictates of the prevailing architectural style. Kohlmaier (1986) contended that these early winter gardens only became a major constituent of the main residential building when they were built at the nobility’s summer residences. Examples of these were the 1806 Indian Villa adjoining Sezincote House, Gloucestershire, England (Figures 38); and the 1845 Villa Berg Conservatory, Stuttgart, Germany (Figure 39). Combined with the technical innovations mentioned earlier and the tremendous wealth generated through the colonial endeavour, the nobility, in particular that of Britain, constructed ever larger and lavish winter gardens. The increase in size and space available on the grounds of the summer residence soon resulted in the winter garden becoming a completely detached building (Kohlmaier & von Sartory, 1986). With this development, the winter garden can be considered a separate typology in its own right. The most apparent example of this type was the Great Conservatory of 1836, at the Chatsworth Estate of the Duke of Devonshire. However, it was not at Chatsworth that the private winter gardens of

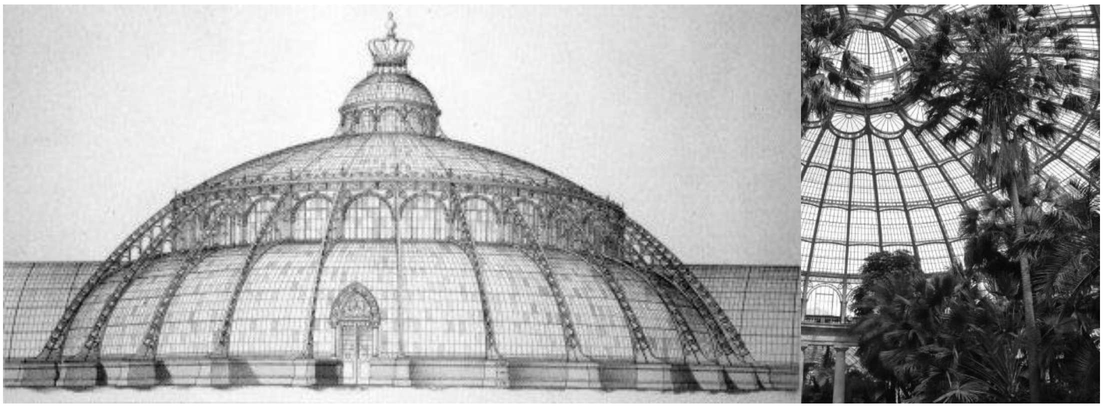


Figure 40 The winter garden at the Royal Glasshouses of Laeken (Image: www.commons.wikimedia.org).

the nobility reached their peak development. Rather, it was in the structures that were constructed at the Royal Glasshouses at Laeken, Belgium, that the crowning achievement of the private winter garden was reached (Figure 40). Starting in 1875, at Laeken, the Belgium King Leopold II constructed a vast complex of 36 interconnected glasshouses, covering an area in excess of 20,000 square metres (Kohlmaier & von Sartory, 1986). At the heart of this vast complex was an enormous, bell-shaped winter garden designed by Alphonse Balat and Henri Maquet (Kohlmaier & von Sartory, 1986). Despite being the most exquisite private winter garden, Laeken also heralded the end of the private winter gardens being associated with the nobility. Within the rising political rights of the middle class, the huge financial cost associated with Laeken could not be sustained or justified. Besides the cost of its construction, the annual 600,000 franc cost of maintaining Laeken resulted in tensions between the king and parliament. Soon, Leopold had to relinquish exclusive use of Laeken to the people of Belgium, and it thus became a 'Palace of the nation' (Kohlmaier & von Sartory, 1986). In 1909, Leopold died, in a small palm pavilion in his beloved glasshouse complex at Laeken. His death ironically also heralded the end to the glasshouse fantasies of the nobility (Hix, 2005).

Kohlmaier (1986) has also discussed the winter gardens of wealthy industrialists. Empowered by newfound wealth, these industrialists soon also sought an opulent lifestyle that could be comparable with that of the nobility. As such, they constructed palatial residences, with large landscaped gardens and with even larger winter gardens. Since their wealth was derived directly from the factory and industry, they built their large estates close to the factories that generated the wealth in a celebratory manner. The close proximity of the factory also allowed the energy of the factory, steam power, to be deployed in the heating of the winter gardens (Kohlmaier & von Sartory, 1986).

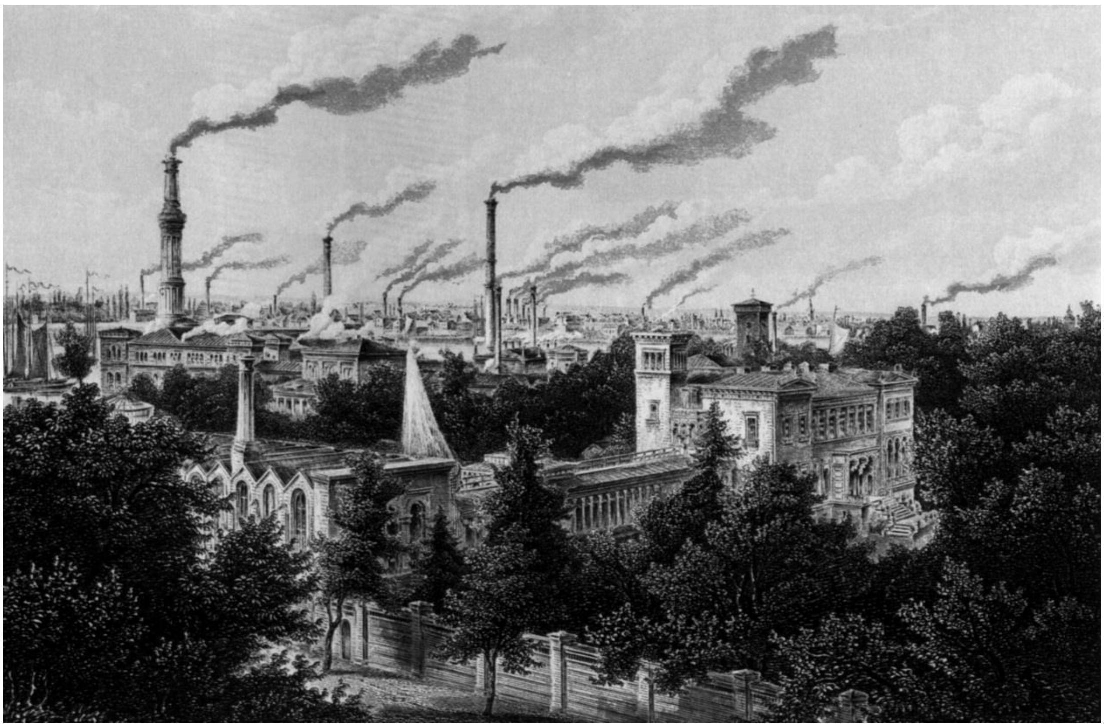


Figure 41 The winter garden (centre foreground) and forcing house (left foreground) connected to the Borsig Villa (Image: www.zeno.org).

Kohlmaier (1986) identified the German industrialists Johann Friedrich August Borsig (who will be discussed in detail later in this chapter) and Louis Fredric Ravené, along with the Danish brewer J. Carl Jacobsen, as having had prominent examples of such winter gardens. Both Borsig and Ravené built extravagant villas, with large palatial gardens, in the industrial Berlin suburb of Moabit. Borsig apparently prided himself on having one the best plant collections in Europe (Kohlmaier & von Sartory, 1986). At the Borsig Villa (1850), both a winter garden, which comprised a colonnaded hall that had a masonry structure with large windows and skylights, and a cast-iron framed forcing house were constructed (Figure 41). Both structures were connected directly to the Borsig Villa; likewise, both were highly regarded and were built from cast-iron components that were cast in the nearby Borsig iron works (Kohlmaier & von Sartory, 1986). Ravené's large villa (1867) was built in *Werftstraße* (Fontane, 1990). So important was Ravené's contribution to the botanical sciences that in 1879, C.D. Bouché, the then director of the Royal Botanical Gardens in Berlin, named the palm genus *Ravenea* after him. In Copenhagen, the classically styled winter garden at the Villa Jacobson (1876) formed an integral component of the Villa and was located directly adjacent to the mansion (Kohlmaier & von Sartory, 1986).

Both the "…peculiar shape and—corresponding to it—the private reception rooms" defined the winter gardens of the aristocracy and the wealthy middle class: "The patron's contemplation of the natural objects he had obtained was intimate, and he shared it only with friends." (Kohlmaier & von Sartory, 1986 p.37). Alternatively, Hix (2005) stated that the grand winter gardens that were being built worldwide in the 19th century were the result of the sole endeavour and influence of a select few. Much like the winter gardens at Laeken, the death of the private winter garden can be illustrated in the fate of the Grand Conservatory at Chatsworth. With the introduction of coal rationing and labour scarcity during World War One, many of the exotic plants subsequently died from both a lack of artificial heat and care. In 1920, instead of being rebuilt and restocked, the Conservatory was demolished after five attempts at dynamiting the building. The private winter garden had thus lost it elite connotations, due to a changed world of increased travel, knowledge, communication and the ready availability of materials - especially glass (Hix, 2005). With a change in taste, no longer was there much desire to mature exotic fruit during the middle of winter, or to view the botanic wonders of the tropics. Rather, the wider public preferred to have a beautiful 'flower garden' (Hix, 2005).

3.6 Public winter gardens

Winter gardens intended for the public encompassed a large variety of typologies and were generally located in larger urban areas. The appearance of these public winter gardens was closely associated with the large-scale availability of prefabricated building elements and modular coordination (Koppelkamm, 1981). As such, public winter gardens in *Floras*, hotels, spas, aviaries, aquariums, conservatories and peoples' or winter palaces soon made their appearance on a global scale (Kohlmaier & von Sartory, 1986), and I will describe these

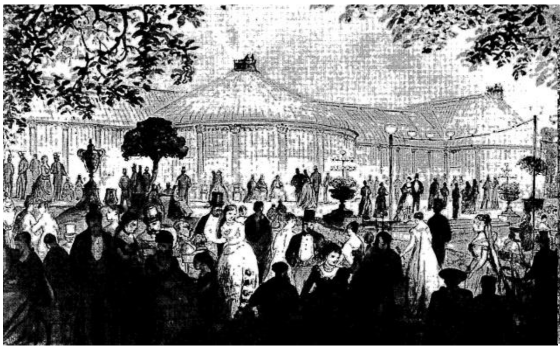
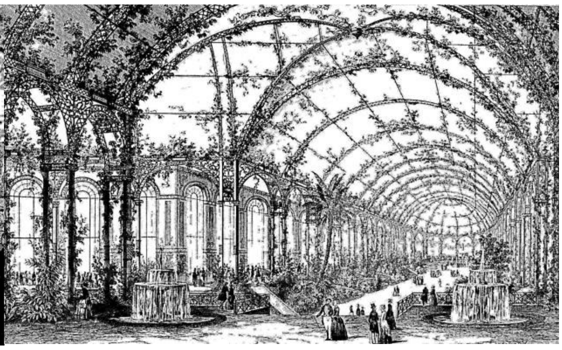



Figure 42 Left - The winter garden for the Royal Botanical Society, Regent's Park, London (Image: Kohlmaier & von Sartory, 1986).
Figure 43 Right - The *Jardin d'Hiver* winter garden, Paris (Image: Kohlmaier & von Sartory, 1986).

Figure 44 The interior of the Berlin Central Hotel (Image: www.commons.wikimedia.org).

manifestations in more detail below. The urban citizenry of Europe felt a need to find a place where they could freely gather without the interference of unpleasant weather. Additionally, the vegetation that the nobility and upper middle classes had become accustomed to also held tremendous attraction to the city-dweller. The very first public winter gardens were generally places of assembly and entertainment, such as dance halls, restaurants and cafés. It soon became evident that the provision of indoor vegetation and glass protection from the weather dramatically increased the attractiveness, i.e. profitability, of such a business (Kohlmaier & von Sartory, 1986). According to Kohlmaier (1986), the very first large-scale public garden was constructed for the Royal Botanical Society (1842–46), and was located in London's Regent's Park (Figure 42). A further early example was the *Jardin d'Hiver*, which opened in 1848 on Paris' *Champs-Elysées* (Figure 43). While Regent's Park was only open on select days and only to the educated public, the *Jardin d'Hiver* was an entertainment venue that was open to all (Hix, 2005; Kohlmaier & von Sartory, 1986). The *Jardin d'Hiver* also differed from Regent's Park in its financing arrangement; the *Jardin d'Hiver* was financed through a joint stock company, while Regent's Park relied on both donations and royal patronage.

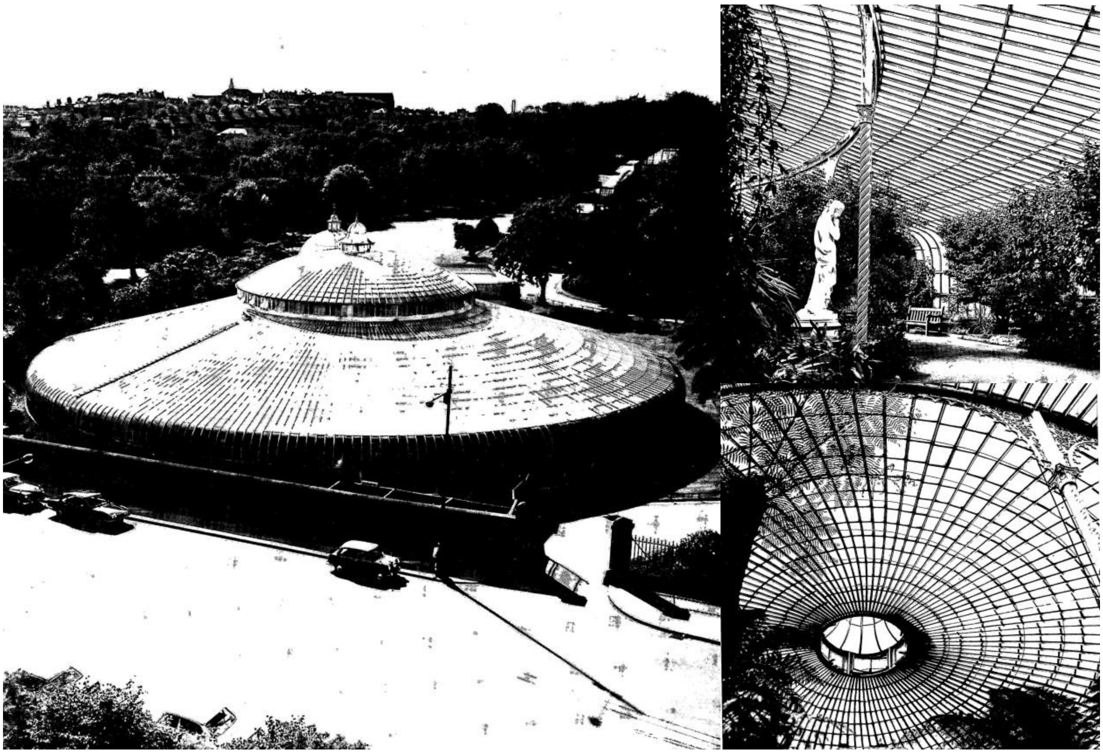


Figure 45 The Kibble Palace in Glasgow (Image: Kohlmaier & von Sartory, 1986).

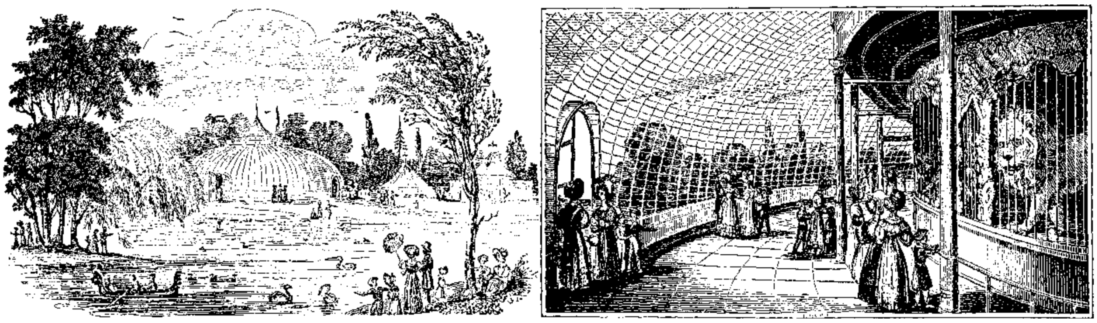


Figure 46 The Glass Menagerie by Henry Phillips (Image: Percy, Timbs, & Limbird, 1832).

In Germany, a curious winter garden typology developed in the form of the *Flora*. These buildings, first constructed in Cologne, then later in Frankfurt and finally Berlin, were mass entertainment venues for the general public's family excursions. Funded by share capital, the *Floras* were multi-storey structures that comprised a large central glazed plant hall, with numerous associated assembly halls leading off from it (Hix, 2005; Kohlmaier & von Sartory, 1986; Koppelkamm, 1981).

Around the middle of the 19th century, the foyer spaces to luxury hotels also appropriated the concept of the winter garden. Much like the *Floras*, these winter gardens formed the central space of the hotel, with restaurants and function rooms leading off from it. Examples of this type included the 1880 Berlin Central Hotel (Figure 44) and the 1868 Leeds General Hotel (Hix, 2005; Kohlmaier & von Sartory, 1986). Further examples of similar *Flora*-type public winter gardens were found in buildings for art, aviaries and aquariums. The intention of these buildings was to combine the beauty of natural fauna and flora with that of manmade *objects d'art*. The privately funded, flat-domed, Kibble Palace in Glasgow (1872) was a prominent, late-period example of this type (Figure 45). It contained depictions of ancient myths, embodied in white marble statues all set within a tropical landscape (Hix, 2005; Kohlmaier & von Sartory, 1986). Containing the art collection of J.C. Jacobsen, the Ny Carlsberg Glyptotek (1897) had a central dome that contained a palm garden, fountains, and marble statues and benches. In the Glyptotek, the art collections were housed in isolated exhibition halls that generally surrounded the palm garden; all overlooked by a library at a higher level. Because of the humidity, all other functions were shielded from the palm garden and, as such, the effect of combining art and nature was not as immediate as in the Kibble Palace (Hix, 2005; Kohlmaier & von Sartory, 1986).

A further privately funded precursor of the modern zoological gardens was to be found in Henry Phillips' Glass Menagerie (1830) in London (Figure 46). Also known as the Zoological Conservatory, the building was a large, flat-domed structure that contained birds and caged beasts. The cages were arranged in a central circle that was surrounded by a colonnade that supported the roof; in turn, an open paved area for the public surrounded the colonnade (Hix, 2005; Kohlmaier & von Sartory, 1986). Kohlmaier (1986) also identified the Berlin aquarium (1869)

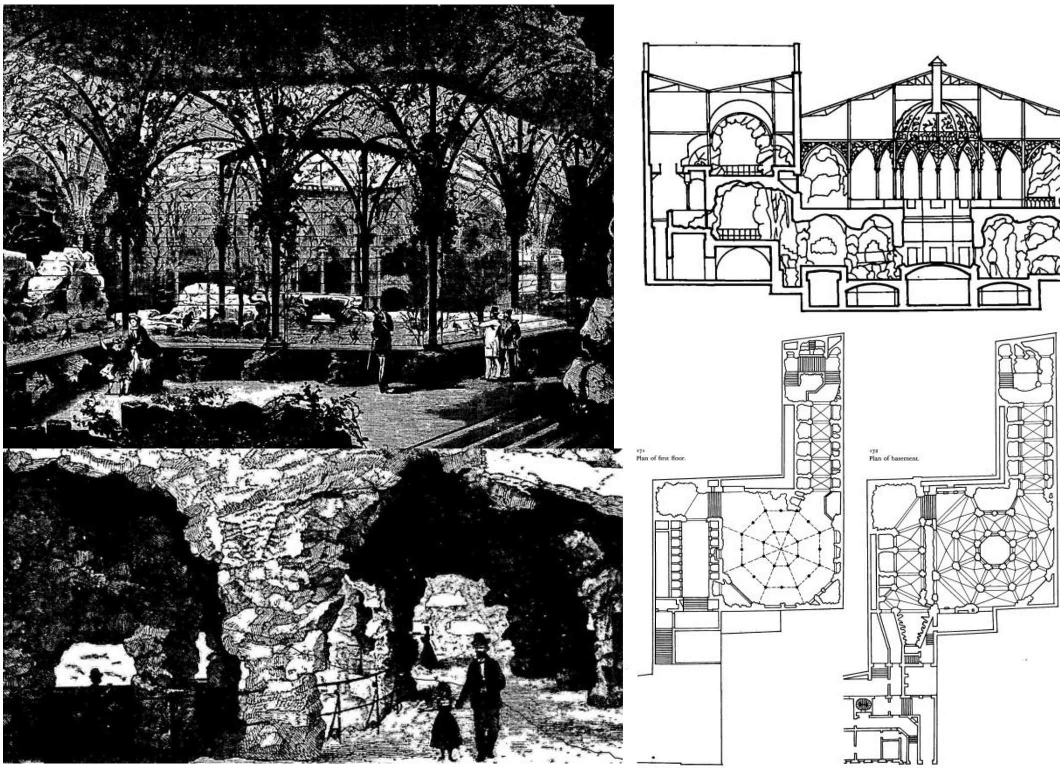


Figure 47 The Berlin Aquarium in *Unter der Linden Straße* (Image: Kohlmaier & von Sartory, 1986).

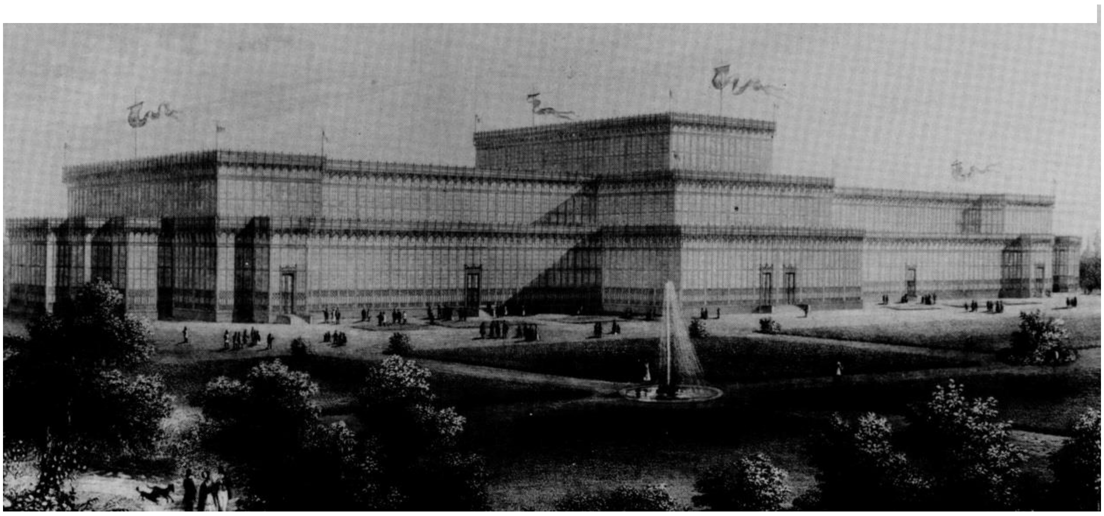


Figure 48 Munich's *Glas Palast* (Image: Kohlmaier & von Sartory, 1986).

on *Unter den Linden Straße* (Figure 47), a two-storey building that was constructed behind a conventional façade, as being somewhat similar to the Glass Menagerie. The Berlin aquarium contained a glazed well that was lit from above. The upper floors housed creatures that lived above the earth's surface, and the lower floor, which contained stone grottos, housed those creatures that lived below the earth's surface (Kohlmaier & von Sartory, 1986). The best-known and last group of public winter gardens were 'people's palaces'. With the advent of Paxton's Crystal Palace

Figure 49 The *Galerie des Machines* at the *Exposition Universelle* of 1889 (Image: www.commons.wikimedia.org).

in 1851, the history of the winter garden reached a defining moment—that being between an earlier period of experimentation and a later one of self-assured propose and engineering (Hix, 2005). If 1800 to 1830 was a period of early fantasies in iron and glass, and 1830 to 1850 an era of experimentation, then 1850 onwards was a period of triumphal expression that led to the heyday of iron-and-glass construction at the turn of the 19th century (Kohlmaier & von Sartory, 1986). The 'assured purpose' of the 1851 exhibition was something different to the earlier public winter gardens. The Exhibition of the Works of Industry of all Nations, or simply The Great Exhibition, was intended to unify both industry and the arts. Prince Albert, the husband of Queen Victoria, considered the Exhibition as contributing to world peace, in that it might have led to a reduction in trade barriers and increased global industrialisation (Hix, 2005). The grand glazed architecture and the bizarre contents of the 1851 Exhibition were intended as a centre of diversion containing useless merchandise and transient experiences. The visual experience of the Exhibition involved the display of machines as works of art, which were set in and alongside gardens, fountains and statues. As such, the great Exhibitions of the 19th century were the origin of the modern-day pleasure industry and mass advertising (Hix, 2005). The winter garden, originally intended as a pleasure spot, had become a social utopia where the working class could discover its educational and leisured nirvana (Kohlmaier & von Sartory, 1986). However, if the somewhat sinister 'assured purpose' of the 1851 Exhibition is ignored, the 'engineering' triumph of the Crystal Palace did set a glass-and-iron precedent for Worlds' Exhibitions that followed, all of which vied to surpass their previous instalment.

In 1854, the *Glas Palast* was constructed in Munich (Figure 48). Located in the Old Botanical Gardens near the city centre and train station, the building was 240 metres long by 84 metres wide, and 25 metres at its highest point. Until it was destroyed by fire in 1931, it served as a multi-functional location for festivals, plays, performances and exhibitions (Hix, 2005; Kohlmaier & von Sartory, 1986). From an 'engineering' perspective, the most important exhibition building was the *Galerie des Machines* (Machine Gallery) at the *Exposition Universelle* (Universal Exposition) of 1889 in Paris (Hix, 2005) (Figure 49). Designed by Ferdinand Dutert, the *Galerie des Machines* had a main hall measuring 240 by 115 metres. The ingenuity of the *Galerie des Machines* lay not only in its gargantuan 3-pinned space frame structure that supported a delicate cladding of white and blue glass, but mainly in the effect that it created. Numerous visitors found this arrangement disconcerting (Hix, 2005). Being taller than the highest Gothic nave, the interior of the gallery was said to be superb. With the provision of electric Edison lamps, it became expansive and infinite during the night. The illuminating effect of moonlight, combined with the light emitted by a centrally located lighthouse, created a wondrous interior of red, blue, lilac, orange and green. Under this illumination, the cladding was described as a web of water (Huysmans, 1889). The grand entrance to the *Galerie des Machines* was via a domed structure called the Grand Vestibule. Its domed ceiling was glazed in sixteen segments of coloured leaded glass. At night, the interior of the dome was lit with electric lighting, an arrangement that was apparently without precedent (Durant, 1999). While the international exhibition buildings of the 19th century often had stylised masonry components, they were essentially independent from the constraints of a prevailing architectural style. Innovative structures like the *Galerie des Machines* prepared the way for the modern movement, where style was a matter of novelty, rather than a dictate (Hix, 2005).

3.7 Winter gardens associated with botanical gardens.

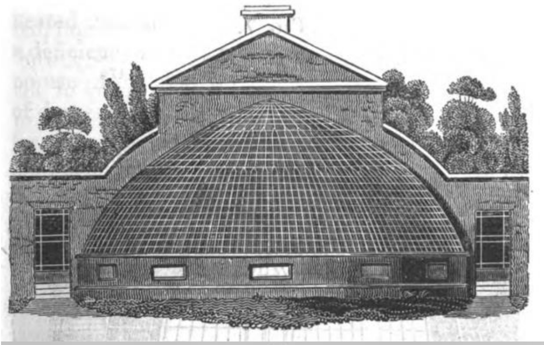
Technically, the structures associated with botanical gardens were glasshouses or conservatories (Koppelkamm, 1981). The very first European 'botanical' gardens were herb, medicinal, kitchen or physics gardens, like those that were maintained by Aristotle and his pupil Theophrastus (Thanos, 2000). During the European Dark Ages, the kitchen gardens of monasteries became important stores of both edible and medicinal plants (A. W. Hill, 1915). However, it was not until the 14th century that 'botanical' or 'physics gardens' were significantly revived, and became widespread in Italy. Botanical gardens like that at Salerno's *Schola Medica Salernitana* (1310) arose as a result of the establishment of early medical faculties. During this period, the interests of 'botanical' gardens were generally devoted to the plants of Asia Minor, the Mediterranean rim and Western Europe (A. W. Hill, 1915). In the 16th century, 'botanical' gardens became more prevalent with the founding of the universities of Padua (1533), Pisa (1544), and Bologna (1568) (Kohlmaier & von Sartory, 1986). These university-associated gardens were arranged to provide for the cultivation of medicinal herbs, or 'simples' (A. W. Hill, 1915). At Padua, Francesco Bonafede founded the first European chair of 'simples' (*Lectura Simplicium*) (A. W. Hill, 1915). Thereafter, botanical gardens were soon established at Zurich (1560), Leiden (1577), Leipzig (1579), Montpellier (1593), Paris (1597), Heidelberg (1593), Giessen (1605), Strasbourg (1620), Oxford (1621), Jena (1629), Uppsala (1657), Chelsea (1673), Berlin (1679), Edinburgh (1680), and Amsterdam (1682) (A. W. Hill, 1915).

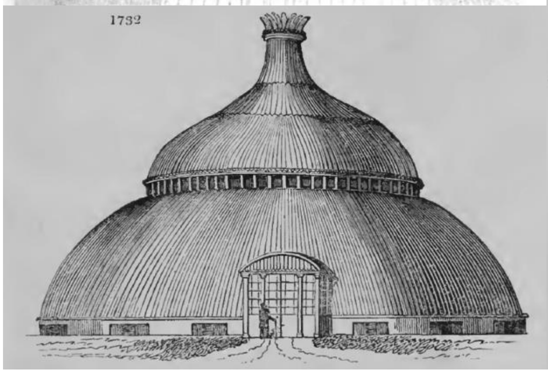
From approximately 1550 onward, a tendency to grow plants not only for practical medicinal purposes but also for aesthetic reasons also developed. From this point onward, a healthy competition developed between botanic establishments to grow as many species as possible (A. W. Hill, 1915). With an increase in maritime trade and discovery, a plethora of new exotic species subsequently became available. As such, artificial environments were constructed, where the vigour of the plants, rather than the human visitor, was of primary importance. Thus, the forms of glasshouses that were associated with botanical gardens were generally dictated by the form and specific needs of the plant being contained (Kohlmaier & von Sartory, 1986). Considering that no plant can thrive without sufficient quantities of light, the form of glasshouses had to be optimised for maximum sunlight penetration. Herman Boerhaave, Carl Linnaeus, Michel Adanson and Nicholas Facio de Douillier were early pioneers in the scientific study of light penetration and resultant glasshouse design (Loudon, 1817).

The countries of northern Europe initially dominated the glasshouse endeavour (Koppelkamm, 1981). The horticultural improvements of the 'Flemings' were held in high regard in all the 'Low Countries' during the 17th century (Loudon, 1817). However, in the early-19th century, Britain became dominant because of its position as the leading industrialised nation of the period, its extensive empire and a traditional passion for gardening (Koppelkamm, 1981). Gentlemen, such as Sir George Mackenzie, Sir Joseph Banks, Charles Macintosh and T.A. Knight, and associations like the Horticultural Society of London dominated; however, it was John Claudius Loudon who became preeminent in the field of horticulture.

3.8 John Claudius Loudon

Loudon was best known for both his preoccupation for the design of spherically formed glasshouses and his pioneering work on the ridge-and-furrow system that Joseph Paxton later perfected (Koppelkamm, 1981). Loudon's fascination with spherically formed glasshouses was initiated through an 1815 article that Sir George Mackenzie wrote to the Horticultural Society of London (Koppelkamm, 1981). In this article, Mackenzie (1815) argued that the most suitable form for glasshouses was one-quarter of the segment of a globe, i.e. a semi-dome. Mackenzie (1815) concluded that this arrangement, applied in section, elevation and plan, would receive the greatest possible quantity of sunlight, and provided both a neat and elegant solution; supposedly when compared to the ridge-and-furrow system. While Loudon (1817) agreed that Mackenzie's form was an elegant addition to horticultural architecture, he disagreed that it was the most suitable form. For Loudon, the best form was not a semi-dome but a "…flattened semi-dome, or segment of an oblate spheroid…" and whose base should not exceed two-thirds of its height (Loudon, 1817 p.20). Loudon added that the form of a '…segment of a circle..." was better, and the "…portion of an ellipse…" was thus best when





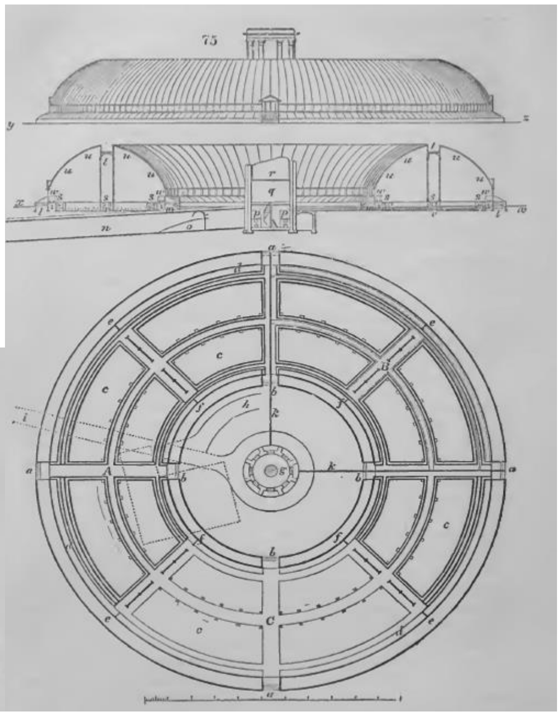
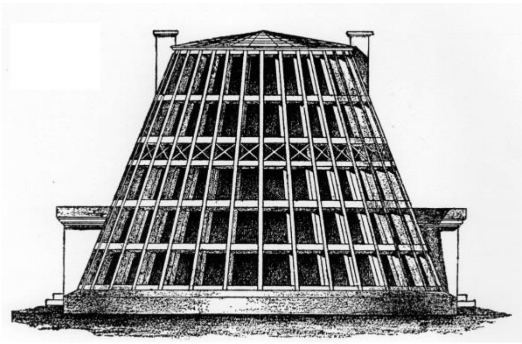


Figure 50 Top left - W. & D. Bailey design for a semi-circular glasshouse for Lord St. Vincent (Image: Loudon, 1824).
Figure 51 Bottom left - W. & D. Bailey design for a glasshouse at Bretton Hall (Image: Loudon, 1836).
Figure 52 Right - Loudon's design proposal for the Birmingham Botanical Gardens (Image: Loudon, 1832).



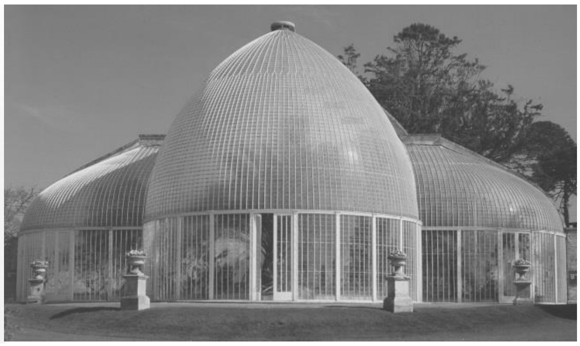
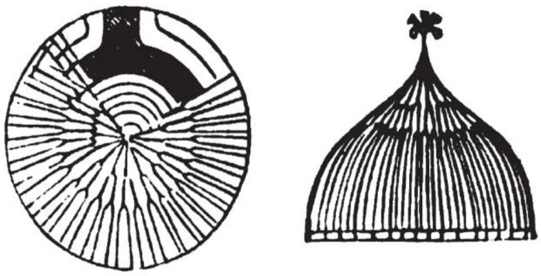


Figure 53 Left - Karl Schinkel's palm house for the Royal Botanical Gardens, Berlin (Image: Kohlmaier & von Sartory, 1986).
Figure 54 Right - Palm house at Bicton Gardens (Image: Hix, 2005).

compared to Mackenzie's pure semi-dome (Loudon, 1817 p.20-1). Loudon's flattened semi-dome, which was praised for its most elegant appearance and satisfactory combination of structural strength and efficiency, was proposed as an important addition to greenhouse, conservatory and botanical hothouse architecture (Loudon, 1817). An accumulated apex to efficiently remove rainwater and a flaring of the base for the planting of small plants were further refinements of the flattened semi-dome. Additionally, Loudon (1817) proposed that a freestanding flattened semi-dome, admitting light through glazing on all sides, was preferable for both aesthetic reasons and the welfare of the plants. Loudon (1817) also discussed the large impact that his freestanding flattened semi-dome would have had on the then accepted practices of glasshouse heating, glazing, ventilation, structure and workmanship. While Loudon might have considered using ridge-and-furrow cladding on a polygonal plan for economic reasons, the glasshouses that he designed after 1818 only ever used smooth curved skins (Koppelkamm, 1981).



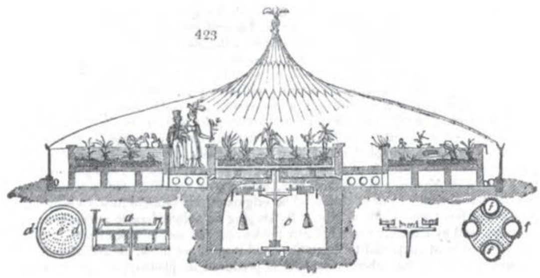


Figure 55 Left - J.C. Loudon’s freestanding flattened semi-dome glasshouse (Image: Loudon, 1822).
Figure 56 Right - J.C. Loudon’s Aquarium or water-plant glasshouse (Image: Loudon, 1822).

In 1816, Loudon design a patented iron sash bar for use in his curved buildings; however, the commercial rights to this invention were transferred to the firm W. & D. Bailey. Two examples of Bailey designs using Loudon’s sash bar were a glasshouse for the nursery of Conrad Loddiges in Hackney, and an 1824 design for a semi-circular glasshouse that stood against a north-facing masonry wall for Lord St. Vincent (Figure 50). In 1827, Bailey produced a design for an imposing glass dome at Bretton Hall in Yorkshire (Figure 51), while in 1831, Loudon submitted a ‘doughnut’-shaped proposal for a glasshouse (Figure 52) at the Birmingham botanical gardens (Koppelkamm, 1981). Kohlmaier (1986) argued that Loudon’s design for Birmingham geometrically resembled Karl Schinkel’s design for the truncated cone-shaped 1821 palm house (Figure 53) at the Royal Botanical Gardens at Berlin-Schoenberg (Kohlmaier & von Sartory, 1986). Koppelkamm (1981) contended that a palm house at Bicton Gardens, whose designer is unknown, was in all probability designed by Loudon and built by Bailey; alternatively, Hix (2005) emphatically stated that it was constructed by Bailey (Figure 54). As well as reiterating his thoughts on the freestanding flattened semi-dome (Figure 55), or as he later termed it, the ‘Accumulated Semi-Globe’, Loudon published his concept for an aquarium or water-plant glasshouse (Figure 56) in 1822 (which I will detail more fully later in this chapter).

The tendency towards a freestanding glasshouse that contained a specific species or vegetation group from a particular geographic location was not, however, new. As outlined above, the orangery and palm house had developed in response to a desire to cultivate these exotic specimens in northern Europe; further common types were dry houses for succulents, orchid houses, and houses for the plants of New Holland (Australia). During the 18th century, the cultivation of pineapples was also in vogue, while in the 19th century, it was fashionable to cultivate, among other things, the Camellia (Koppelkamm, 1981). As such, Loudon designed a curvilinear pineapple and vine glasshouse in 1817, which was constructed for a Mr Stuckey at Langport in Somerset (Hix, 2005).

As both the technology of iron construction and the industrial revolution progressed, so too did the size and audience of the horticultural glasshouse. By the second half of the 19th century, particularly the 1870s and 1880s, prefabricated and mass-produced greenhouses became the norm (Koppelkamm, 1981). With the construction of Paxton's Great Conservatory at Chatsworth, an important era in glasshouse development came to an end. The Conservatory not only demonstrated the large-scale possibilities of an iron structure, but it was also the first large glasshouse to allow daylight in from all sides. From this point onward, it was Loudon's and Paxton's buildings that firmly established the precedent for any successive development (Koppelkamm, 1981). These subsequent developments of size and iron were best illustrated by the public winter gardens mentioned above, but also by large-scale palm houses, to which I will now turn.

3.9 Palm houses

Early examples of palm houses were those at Syon House (1820–27), the glasshouses (*Le Botanique*) at the Brussels Botanical Gardens (1826), and The Great Conservatory (1822) (*Große Gewächshaus*) in the Mountain Park (*Bergpark*) in Wilhelmshöhe, Kassel (Koppelkamm, 1981). These early palm houses were much like their orangery predecessors in that they were dictated by prevailing

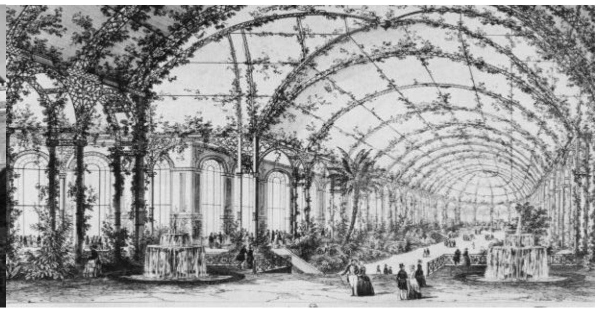
 

Figure 57 Left - The palm house at the Belfast botanical gardens (Image: www.commons.wikimedia.org).
Figure 58 Right - The *Jardin des Plantes* at the Museum of Natural History, Paris (Image: Kohlmaier & von Sartory, 1986).

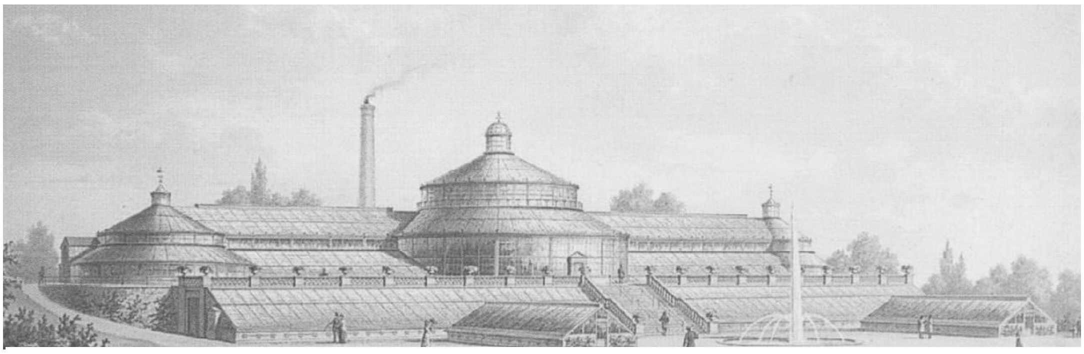


Figure 59 The Copenhagen palm house (Image: Hix, 2005).

architectural style and their owners' aristocratic tastes. Koppelkamm (1981) argued that once again it was the Britons, this time Richard Turner and Decimus Burton, that led developments. The palm house at the Belfast Botanical Gardens (1839–40) (Figure 57), designed by Charles Lanyon, was one of the first structures to be associated with Turner. In the mid-19th century, as palm houses increased in both size and prestige, architects inevitably became involved because of the desire for aesthetics. However, because of the complexity of these large glasshouses, architects needed to work with engineers and fabricators in completing the final building (Hix, 2005). Turner was therefore ideally positioned, as he was both the owner of the Hammersmith Iron Works in Dublin, and an engineer and designer.

In 1843, Turner designed and constructed the palm house for the Royal Dublin Society, at Glasnevin, Dublin. Turner and Burton were best known for the palm house (1845–49) built for the Royal Botanic Society of London at Kew Gardens (Hix, 2005). By this stage, horticultural glasshouses generally started to appear in the centre of grouped complexes. This central glasshouse contained taller tropical species but mainly palms. It was loosely referred to as the palm house. Adjacent to this large, central structure were a number of lower, less prominent wings for smaller species, either grouped by similarities or by geographic location. These wings generally had different climates from the central, tropical palm house.

This typology developed because of two factors. The first was the prevailing prototype developed for the nobility, such as the orangery or the winter garden, attached to the stately mansion. The second was economic. As the number of species and resultant geographically dispersed specialised glasshouses proliferated, so too would the cost of maintaining the artificial climate and associated equipment. It would seem logical to group these dispersed glasshouses in one location and 'power' them using centrally located equipment. While Britain might have led the initial development of public palm houses, enthusiasm for glasshouses was just as intense on continental Europe (Hix, 2005). Earlier British glasshouses, or palm houses, tended to be curvilinear. This contrasted with later German examples, which tended to be rectilinear and classical in style (Hix, 2005; Koppelkamm, 1981). It has even been proposed that the curved roof never became popular in Germany (Koppelkamm, 1981). While German designers were very familiar with British developments, iron was regarded as simply too expensive even as late as the mid-19th century, which led to the preference for traditional building materials like timber, which resulted in a straight surfaces, regular plans and span-roofs (Koppelkamm, 1981).

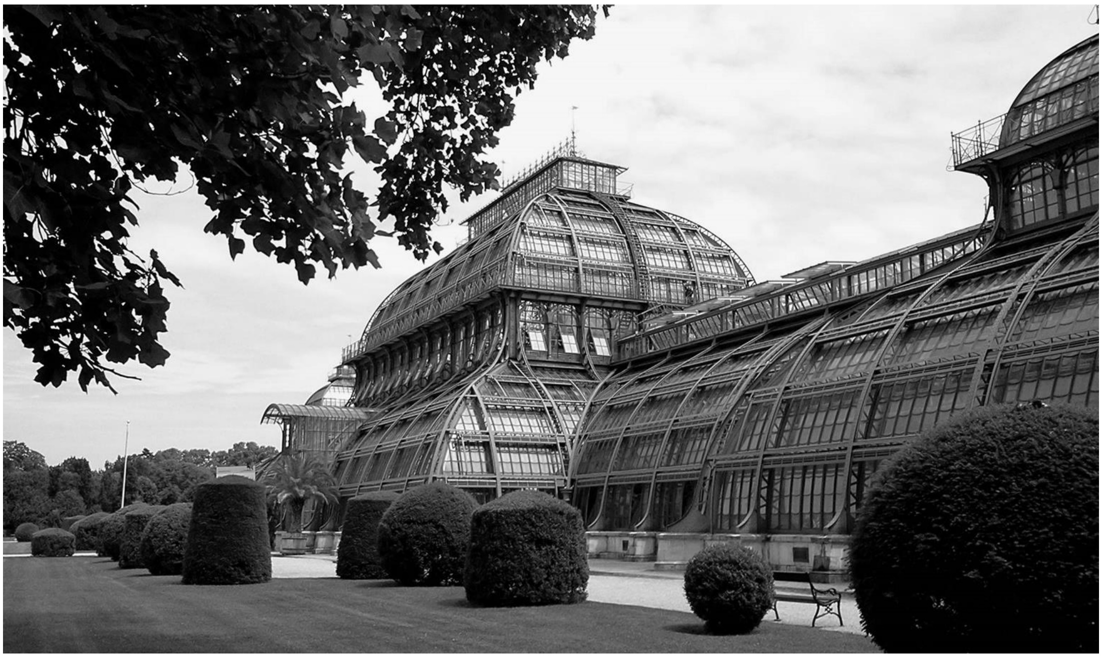


Figure 60 The palm house at Schonbrunn Botanical Gardens in Vienna (Image: By author).

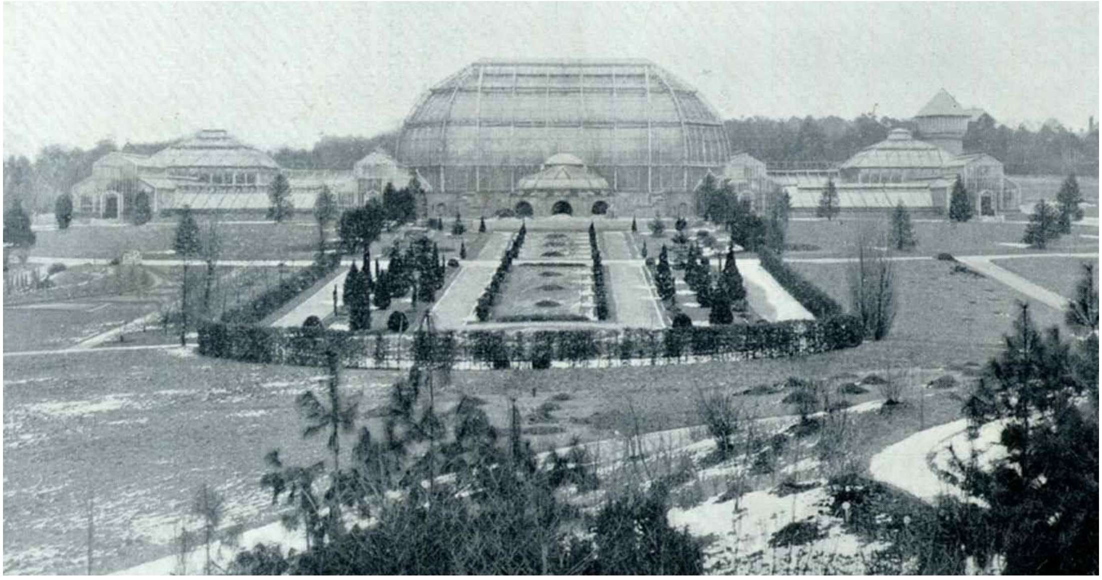


Figure 61 The glasshouse complex at Berlin Botanical Gardens at Dahlem (Image: www.commons.wikimedia.org).

However, in the rest of continental Europe, curved roofs did appear. Charles Rohault de Fleury designed a large glasshouse complex (1833–34) for the *Jardin des Plantes* at the Museum of Natural History, Paris (Figure 58). De Fleury's glasshouses were described by Gideon (1976) as having been both the prototype for all large iron-framed conservatories, and the first large structure to consist entirely of iron and glass. However, this is inaccurate, as the first was a glasshouse constructed at Stuttgart-Hohenheim in 1789. According to Hix (2005), this building was, in all probability, the first iron-framed glasshouse in Germany. The Copenhagen palm house (1872), designed by Tyge Rothe, was a further example (Figure 59). Built in the same form as the Brussels Botanical Gardens and occupying a site similar to that of *Jardin des Plantes,* the Copenhagen palm house was commissioned by the previously mentioned brewer Jacobsen. While both the glasshouses at Brussels Botanical Gardens and Copenhagen were not exactly curved, their truncated, coned centres created a pleasing and rational building (Hix, 2005).

In Germany, most large palm houses were only built after 1860 (Koppelkamm, 1981). While many, similar to that at Strasbourg (1877–82) and Munich Botanical Gardens (1860–5), were 'regular' (as described above), the one at Vienna, Schönbrunn (1884), was closer to the British curved type (Figure 60). While it was not as elegant as the Kew example, because of protruding skylights that were arranged along the ridge line, the Schönbrunn example was innovative because of

Figure 62 Top - The glasshouse complex at The Golden Gate Park, San Francisco (Image: Hix, 2005).
Figure 63 Bottom -The glasshouse complex at the New York Botanical Garden (Image: Hix, 2005).

its placement of the structure to the outside of the glazing (Koppelkamm, 1981). Hix (2005) referred to the Schönbrunn glasshouse as being having been a prominent example of expressed structural ironwork. The new glasshouse complex (1905–7) in the Berlin suburb of Dahlem, for the German Royal Botanical Gardens (Figure 61) was undoubtedly inspired by Schönbrunn. This complex was designed by the Royal Building Inspector, Alfred Koerner, and contained several interconnected climatic chambers, centred on a large palm house. Like the *Galerie des Machines*, this large palm house had a three-pinned portal structure (Hix, 2005). However, unlike the *Galerie des Machines*, the structure was placed outside of the glazing. Similarly, like both the *Jardin des Plantes*, *Le Botanique* and the palm house at the Copenhagen Botanical Gardens, the building occupied a sloping site.

Two remarkable examples of large-glazed palm house complexes also existed in the United States of America. In San Francisco (Figure 62), a group of wealthy citizens donated a British prefabricated complex to the city park administration. Opened in 1879, the timber-structured complex followed the accepted typology of a prominent central pavilion with two radiating wings (Koppelkamm, 1981). In New York (1900–2), another glasshouse complex was constructed that was representative of those in many major cities of the period (Hix, 2005) (Figure 63). This glasshouse, designed by William Cobb, was modelled after the British curved prototype (Koppelkamm, 1981). However, the heyday of the glasshouse was undoubtedly the second half of the 19th century.

By the beginning of the 20th century, and as later amplified in a post–World War One world, the building material of reinforced concrete, competing ideologies, and modernism appeared to displace existing conditions. Apart from the few examples listed above, the infatuation for large glass-and-iron structures rapidly dissipated and they were subsequently rendered redundant.

3.10 *Victoria regia* glasshouses

As discussed, Loudon's curved, smooth-skinned botanical glasshouses first appeared in Britain, and were initially uncommon in continental Europe, especially in Germany. This situation is reversed with the wide range of botanical glasshouses developed for species with specialist climatic requirements, such as camellias and orchids; i.e. curved-form glasshouses for these species first developed in continental Europe. Initially, only species like citrus were collected and propagated. As European colonialism and industrialisation aggressively spread, the desire to collect even larger plant specimens as part of ever-increasing collections likewise dramatically increased. This in turn resulted in more numerous, larger and increasingly complex glasshouses. Along with the palm houses, which contained the largest or tallest of species, a proliferation of equally specific and functionally optimised glasshouses, such as the camellia, lily, aquatic and orchid glasshouses also resulted.

Following the first European cultivation of the *Victoria regia* lily in 1849, a specific glasshouse, the *Victoria regia* glasshouse, was developed (Hix, 2005). Glasshouses generally acquired their names according to a rational, scientific classification—either botanically, according to their wider *family* (e.g. palm houses), or sub-family, or *genus* (hence, camellia and lily glasshouses). Alternatively, glasshouses were also named geographically, according to their original climatic regions (e.g. sub-tropical glasshouses). The naming of a glasshouse according to a specific *species*—namely, the *Victoria regia* glasshouse—was consequently extremely uncommon. This would indicate that there was something extraordinary about *Victoria regia* lily.

3.11 The initial European cultivation of the *Victoria regia*

In the 19th century, Joseph Paxton, the Head Gardener for the Duke of Devonshire at his Chatsworth Estate, was considered an eminent cultivator of exotic plants. In 1836, Paxton tested a curvilinear pleated (ridge-and-furrow) roof on a 60-by-26 feet forcing-house, which became the initial home for *Victoria regia* lily until the construction of a subsequent, even more specific glasshouse (Jones-Loyd, 1851). Owing to his status, Paxton had received a *Victoria regia* seedling from the Kew Royal Botanical Gardens on 3 August 1849 (Cavendish, 1999). Initially, he placed the seedling in a 12-square-foot, heated tank that was protected by the curvilinear roofed glasshouse (Flanders-Darby, 2002).

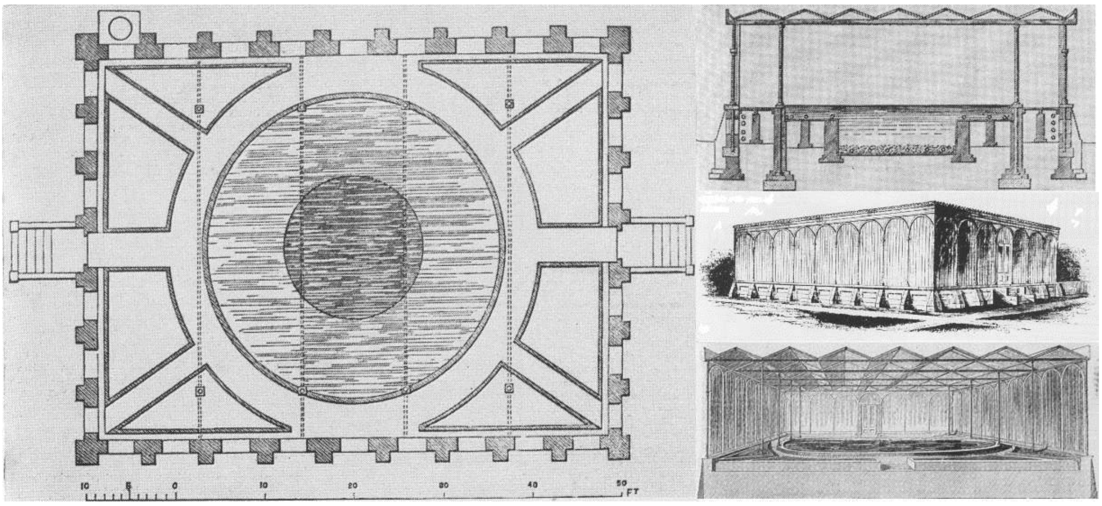


Figure 64 Joseph Paxton's 1850 *Victoria regia* glasshouse (Image: Chadwick, 1961).

The *Victoria regia* did phenomenally well in this initial artificial environment; within a mere six weeks after its initial planting, the leaves measured 3 feet 6 inches in diameter. On 1 October, the leaves had increased to 4 feet in diameter, and, by 15 October, to 4 feet 5½ inches (Lindley, 1849). At this stage, *Victoria regia* outgrew its initial pool and had to be relocated to a larger tank, which was twice the size of the first (Flanders-Darby, 2002). Continuing its phenomenal growth, *Victoria regia* then outgrew its pond on a further two occasions (Markham, 1935).

The *Victoria regia* lily flowered for the first time in Britain between 8 and 10 November 1849. On 15 November 1849, Paxton personally presented one of its initial flowers and a large leaf to Queen Victoria (Harley & Harley, 1992). Having discovered *Victoria regia*'s cultivation requirements in the experimental forcing-house, Paxton then began to construct a purpose-built glasshouse (Figure 64) that was completed in the spring of 1850 (Chadwick, 1961). Paxton described this structure as having measured 61 feet 6 inches long by 46 feet 9 inches wide. At the centre of this rectangular plan was a circular pond for *Victoria regia*, which measured 33 feet in diameter. This pond had a deeper central portion measuring 16 feet in diameter, and contained the soil for the *Victoria regia*. Eight smaller ponds were additionally located in the corners of the house (Lindley, 1850). These eight smaller tanks contained other exotic aquatic species, such as *Nymphaea*, *Nelumbium* and *Pontederia*. Sitting on almost square foundations, the building consisted of a masonry base that rose 37 inches from the ground. Contained within this base were the raised ponds, their heating pipes and low-level ventilation openings. Four-inch iron heating pipes were embedded in the deep central soil of the pond, while 2-inch lead pipes were additionally placed in the shallower portion of the pond. The house was heated by 2-inch iron pipes that ran between the piers of the basement wall. Air flowed over the heating pipes and into the house through 30 low-level openings in the basement walls. Stale, heated air was expelled through roof openings operated by simple machinery.

Within the central pond, four small waterwheels added a gentle motion to the water, and, above each, a supply of cold water was provided to 'normalise' the temperature of the pond as required (Chadwick, 1961). Above the masonry base, Paxton's *Victoria regia* glasshouse extended upwards in glass, wood and steel. The main vertical structural façade consisted of cast-iron columns at 6-foot intervals, which were topped with rounded arches. Behind this façade, a secondary structure of vertical glazing was constructed; specifically, it consisted of wooden sash bars that contained 5-by-10-inch glass panes. The horizontal glazed roof of the building was a ridge-and-furrow system, with a parallel Paxton Gutter housed in the valleys or furrows. Before this *Victoria regia* glasshouse, Paxton had used his gutter as the main structural support to the ridge-and-furrow roof. Paxton then developed an independent structural support system that ran perpendicular to both the gutter and the ridge-and-furrow. This comprised four 54-inch wrought-iron master joists that were 5 inches deep, with the addition of 1-inch-diameter steel tie-rods below. Supporting each of the master joists were two hollow 3½-inch cast-iron columns (Chadwick, 1961).

With the development of distinct structural and cladding systems, Paxton's *Victoria regia* glasshouse gradually emphasized the horizontal space-frame. One could rightly enquire as to why he did this. On previous occasions, Paxton noted that he was impressed by the massive carrying capacity of the *Victoria regia*'s leaves. In 1849, after the *Victoria regia* had initially bloomed, Paxton placed his seven-year-old daughter Annie on one of its leaves, a weight it carried with ease. In early May 1850, Paxton conducted the same experiment with a leaf of 5 feet in diameter in a small stream near the Kitchen Gardens at Chatsworth. For this later experiment, Paxton constructed a lightweight circular trellis that was placed on the leaf surface so as to distribute the applied weight evenly. Paxton placed 112 pounds of weights onto this trellis before water started to flow over the upturned edges of the leaf. After the weights were removed, two men of approximately 10 to 11 stone were individually carried by the leaf for a period of between two and three minutes (Allen, 1854). On 13 November 1850, Paxton presented a series of drawings of his Crystal Palace building to the Royal Society of Arts. Along with the drawings, Paxton also presented a leaf from his *Victoria regia* lily, and noted that its underside represented an excellent example of natural engineering:

> …in that the cantilever that radiate from the centre, where they are nearly two inches deep, with large bottom flanges and very thin middle rib, and with cross girders between each pair to keep the middle ribs from buckling… (Jones-Loyd, 1851 p.6).

Paxton admitted that the origin of the Crystal Palace derived from his gardening experiences, particularly from the glasshouse that he built for *Victoria regia* (Paxton, 1850). As Fay quotes: "[it is] …to this plant and to this circumstance that the Crystal Palace owes its direct origin" (Fay, 1951 p.11). While history generally acknowledges Paxton as having been responsible for the first European blooming of *Victoria regia*, this could be argued as only partially, or even totally, incorrect.

In May 1849, the German horticulturalist Karl Eduard Ortgies was hired to work at Chatsworth, where he was later entrusted by Paxton with the daily care of *Victoria regia* (Wittmack, 1894). It was Ortgies who reported to Paxton that the first bud was about to open on 8 November 1849 (Wittmack, 1894). As mentioned above, this first blooming did not occur in Paxton's celebrated *Victoria regia* house; rather, it took place in the experimental ridge-and-furrow forcing house he had designed in 1836 (Jones-Loyd, 1851). As such, Paxton's design of the later *Victoria regia* house raises the question as to what interested him the most—the botanical habits of lily itself, or the building of a glasshouse that best framed the achievement of bringing the lily to bloom?

These two factors were undoubtedly of concern to Paxton. However, it was the design of a further and larger iteration of his ridge-and-furrow structural glazing system that interested him the most. In the wake of his 1836 building, and the Great Conservatory, Paxton was already been refining this system, and in 1840, he first employed it horizontally in a conservatory at Darley Dale (Jones-Loyd, 1851). A full nine years later, Paxton had the opportunity to deploy the 'final solution' in relation to a horizontal ridge-and-furrow roof (Chadwick, 1961), the use of which dictated the resultant cuboid form of Paxton's *Victoria regia* glasshouse. For Paxton, the *Victoria regia* glasshouse was intended as the final prototype before the full-scale deployment of the ridge-and-furrow system on even larger buildings, such as the Crystal Palace of the Great Exhibition of 1851. According to Kohlmaier (1986), Paxton intended that his ridge-and-furrow system both be optimised for mass production and widely applied to a variety of buildings, including dwelling houses, railway stations and assembly halls.

3.12 Further British examples of *Victoria regia* glasshouses

The *Victoria regia* seedling for Syon House arrived during the "…second week of September, 1849", and was initially nurtured in a number of increasingly larger

Figure 65 The *Victoria regia* glasshouse at The Royal Botanical Gardens, Kew (Image: www.commons.wikimedia.org).

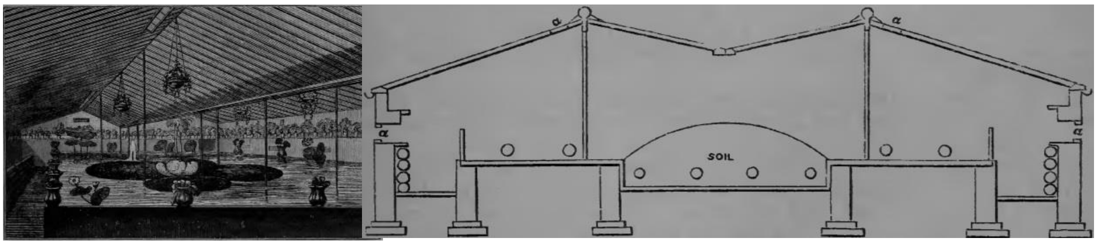


Figure 66 The *Victoria regia* glasshouse at The Exotic Nursery in Kings Road, Chelsea (Image: Weale, 1851).

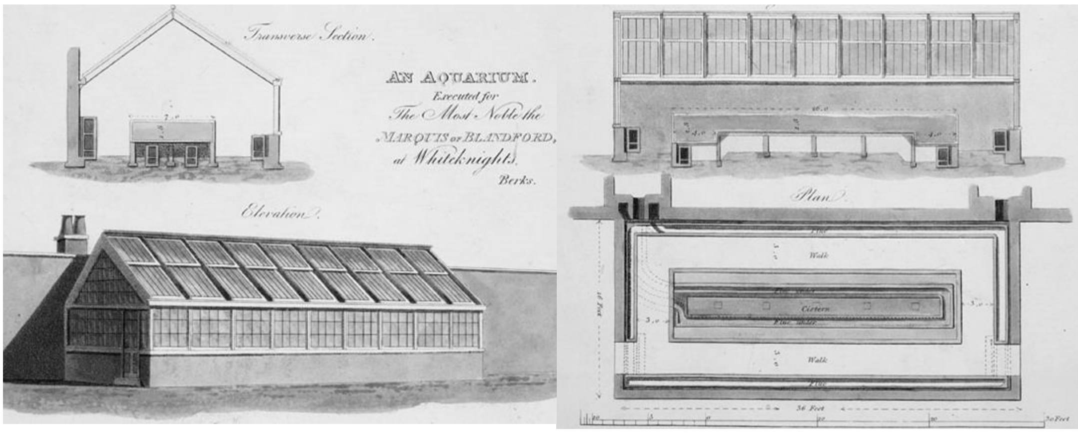


Figure 67 The Aquarium for the Marques of Blandford at White Knights (Image: Tod, 1823).

pots that crucially allowed for the continual movement of water (Moore & Ayres, 1850 p.229). On 5 January 1850, the lily was moved to "…a low-roofed lean-to house, in which a Mr Beck had been ordered to prepare a slate tank for its reception, twenty-two feet long by twelve feet wide" (Moore & Ayres, 1850 p.230). In this tank, water movement was facilitated by a small water wheel that was placed under the main water-supply pipe. This *Victoria regia* flowered in the lean-to glasshouse on 10 April 1850 (Moore & Ayres, 1850). After this blooming, the

Victoria regia at Syon was apparently moved again. In 1851, its location was described as having a "…span-roof erection, with a porch and second door … It contains a slate tank 21 ft. square, which is occupied principally by the Victoria. … Several other aquatics …are grown at the sides and towards the corners of the tank" (Weale, 1851 p.509-10). Thus, this later structure is clearly not the same as the glasshouse in which the *Victoria regia* first flowered. Additionally, in this later glasshouse, the *Victoria regia* was described as having been planted in the centre of the tank, surrounded at the edges, chiefly, by *Nelumbium*. The hot-water supply to the tank ran over a small water wheel, providing motion to the water in the tank (Weale, 1851). Both Paxton's *Victoria regia* glasshouse at Chatsworth and the 1851 *Victoria regia* glasshouse at Syon were located in kitchen gardens (Flanders-Darby, 2002; Weale, 1851).

The cultivation of the *Victoria regia* lily at Kew followed a similar pattern as Syon and Chatsworth; i.e., in all cases, the lily first bloomed in back office–type environments before a glasshouse was either purpose built or converted for it. As the initial cultivator of the Chatsworth and Syon lilies, The Royal Botanical Gardens, Kew produced its first *Victoria regia* flowers in June of 1850 (Desmond, 1995). Kew appears to have first propagated the *Victoria regia* sometime after June 1846. Of the 25 seeds bought, only two germinated and formed rudimentary leaves, and then promptly died (Desmond, 1995).

Undoubtedly inspired by this event, in 1847, William Hooker, as Director of The Royal Botanical Gardens, published details of the *Victoria regia* in both *Curtis's Botanical Magazine* and a special edition book (Hooker, 1847a, 1847b). Subsequently, in February 1849, Kew received seeds of the *Victoria regia* in small phials of purified water. From these seeds, in March of the same year, Kew subsequently germinated half a dozen vigorous plants, and, by midsummer, had raised 50 in a former tropical propagation glasshouse (Desmond, 1995). Both the Chatsworth and Syon lilies originated from these 50 plants (Desmond, 1995). In 1849, a combination of poor lighting and impurities in the water supplied from the River Thames resulted in the Kew lilies dying without producing flowers. In 1850, the *Victoria regia* was finally bought to flower "…in a large tank in the former tropical propagation house…" (Desmond, 1995 p.185). Having discovered the initial cultivation requirements of the lily, Kew also constructed a dedicated glasshouse for the lily.

The design of the Kew Gardens' *Victoria regia* glasshouse, or Water Lily House (Figure 65), which still exists, was initially attributed to Richard Turner; however, the actual designer is unknown (Desmond, 1995). Before the construction of this glasshouse, the *Victoria regia* was on display at Kew Gardens in "House No. 6", which was apparently "…one of the very few places where it can be seen by the public…" (Weale, 1851 p.474-5). When it was time to build a dedicated glasshouse, Hooker initially proposed a "…house, 100 feet long, with two tanks—one for the *Victoria regia* and the other for aquatics". However, this plan was vetoed by the then Commissioner of Works in favour of the current Water Lily House (Desmond, 1995 p.186). The new span-roofed 1852 *Victoria regia* glasshouse, whose construction was supervised by the Commissioner's district manager, was finished in December 1852. According to Desmond (1995), this glasshouse did not suit the *Victoria regia* as it was poorly designed and ventilated. As such, in 1858, the *Victoria regia* was moved to a "…square slate tank in one of the smaller houses, while much of its former abode was transformed into a tropical habitat of white, blue and red water lilies, ferns, papyrus and hanging gourds" (Desmond, 1995 p.186).

Other early examples of regular *Victoria regia* glasshouses were found at The Exotic Nursery in Kings Road, Chelsea; the Herrenhausen Gardens in Hanover; and the old Berlin Botanical Gardens in the suburb of Schöneberg. A brief discussion of each follows. The *Victoria regia* glasshouse at The Exotic Nursery (Figure 66) was described as having had a plan of 37-by-30 feet and covered by a glazed two-span roof supported by iron columns. This glasshouse was correctly referred to as an aquarium (Weale, 1851), which was a generic 19th century term used to describe a glasshouse for aquatic plants. Hix (2005) identified two earlier glasshouses that used the term aquarium; one belonged to the Marques of Blandford, and was housed in Whiteknights Park, Reading (Figure 67), and the other was Loudon's prototype of 1822. At the centre of The Exotic Nursery glasshouse's plan was a slate tank, 30 feet by 22 feet 9 inches, in which the *Victoria regia* was located. A path on three sides surrounded this central tank, while the fourth (and eastern) side of the tank abutted the edge of the building, which allowed the cultivation of tall aquatics, such as papyrus. In addition to the *Victoria regia*, the tanks also contained *Nymphcea, stellata, rubra, coerulea*, and *sanguine*. Small vases, at 7-feet intervals, that contained *Nymphoea pygmoea* were placed on the lip of the tank. Additionally, the underside of the glazed roof had suspended pendant vases for orchids and other species. Water movement in the tank was achieved, not through the use of a water wheel, but by an 'off axis' copper vessel that was fixed under the main water supply. When the level of the water in the copper vessel reached a certain level, it would then tip into the tank, agitating the water surface (Weale, 1851). While this means of water movement was considered novel, it was felt that the appearance of the "…little device may be clothed in a more elegant form" (Weale, 1851 p.536).

3.13 Continental European examples of *Victoria regia* glasshouses

The Herrenhausen Gardens had long been associated with the royal families of Saxony. In 1841, the eminent botanist and Director of the Gardens, Heinrich Ludolph Wendland, laid out an orchids and cuttings glasshouse in the Mountain Garden (*Berggarten*) portion of the Herrenhausen Gardens. In the spring of 1851, the architect Georg Heinrich Schuster provided the plan for the conversion of this glasshouse, so as to cultivate *Victoria regia*, which flowered for the first time on 29 June 1851. This *Victoria regia* glasshouse (Figure 68) was low span-roofed structure of approximately 43-by-23 feet, which contained a large tank at one end that measured approximately 32-by-21 feet. Unlike the *Victoria regia* glasshouses at Chatsworth, Kew, Syon and Chelsea, the Herrenhausen glasshouse did not have an

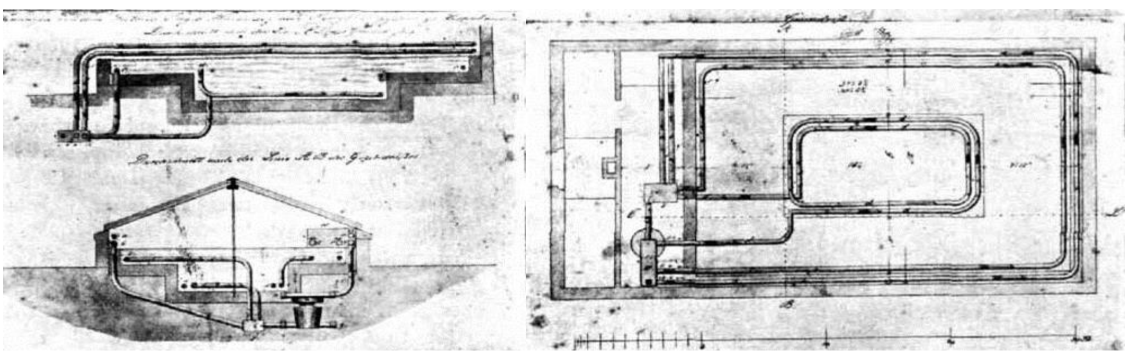


Figure 68 Georg Heinrich Schuster's *Victoria regia* glasshouse at Herrenhausen (Image: Meyer & Schultze, 1916).

interior circulation route for visitors; the tank was immediately surrounded by a low masonry wall, 1 foot wide and 3 feet high, which served as the perimeter wall to the glasshouse (Meyer & Schultze, 1916). Therefore, it would appear as though visitors to the Herrenhausen *Victoria regia* would have viewed the lily from the outside, rather than the inside. Interestingly, the seeds for the Herrenhausen *Victoria regia* were procured from Syon House and the Royal Botanical Gardens, Kew (Meyer & Schultze, 1916).

In May 1852, the Director of the Berlin Botanical Gardens, Schöneberg, Professor Alexander Braun built a heated glasshouse for tropical aquatic plants. Earlier Braun demanded that the honour of the Gardens be protected by bringing *Victoria regia* to its highest perfection. Carl Freidrich Bouche, as the Berlin Botanical Gardens' Technical and Horticultural Director, obtained seeds for *Victoria regia*

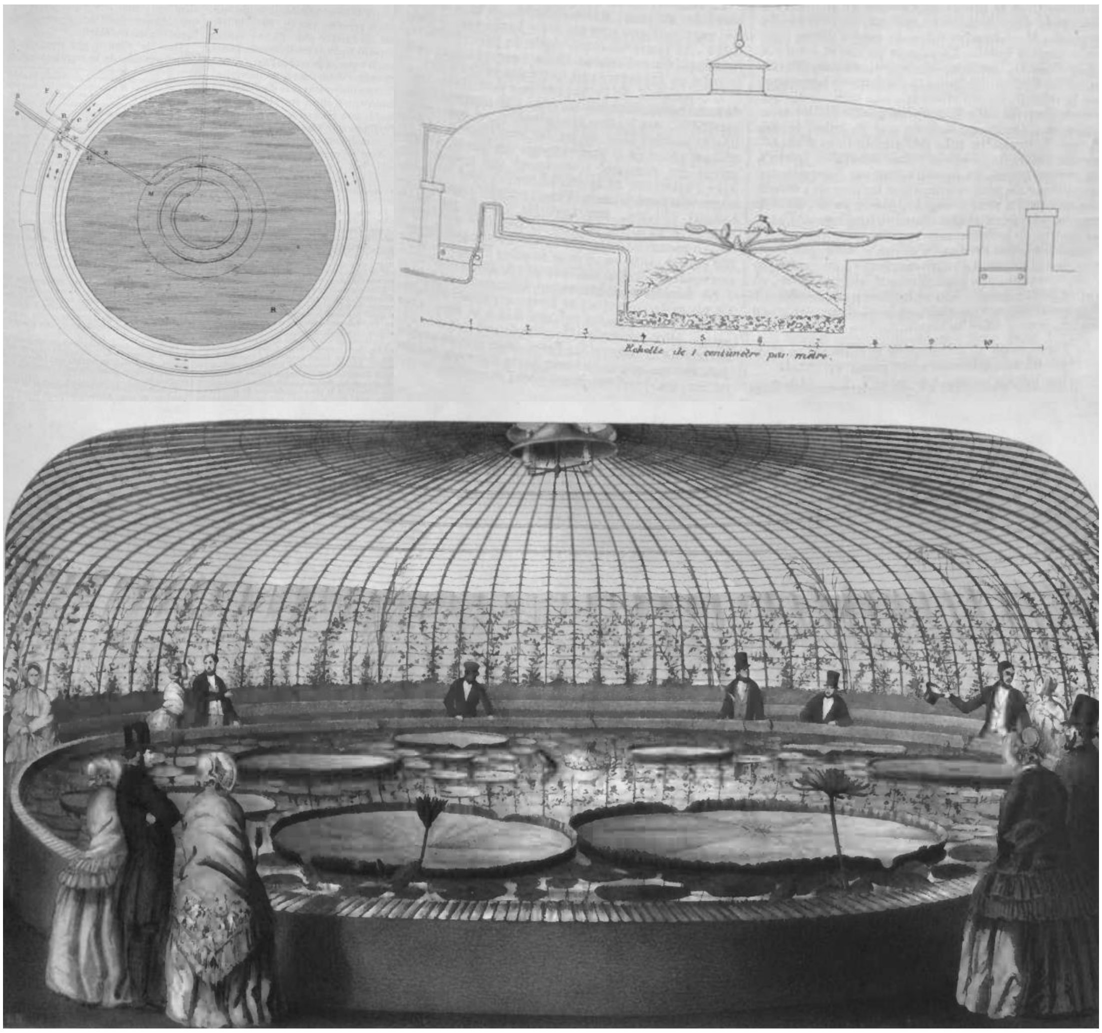


Figure 69 The Eduard Ortgies designed *Victoria regia* glasshouse for the nursery business of Louis van Houtte (Images top: van Houtte, 1850-1; bottom: van Houtte, 1851-2; www.commons.wikimedia.org).

apparently on a trip to Hamburg in 1851. Built according to Bouche's plans, the *Victoria regia* glasshouse was described as a simple square commercial building with oil-painted wooden walls, which contained a cistern made from concrete or cement. The gabled roof to the glasshouse was framed in timber and in-filled with glazing (Lack, 2004). The heating of this glasshouse was rather crude because the hot water flowed directly into the cistern, which resulted in large water temperature differences within different parts of the cistern. Additionally, this continual movement of water through the boiler, which had been in contact with outside organisms, caused the growth of algae, which in turn hindered the vitality of the *Victoria regia*. When the glasshouse was demolished nearly three decades later, a fountain was built in its place (Schultze, 1883).

At the Berlin Botanical Gardens, the *Victoria regia* was the central attraction, drawing large numbers of both scientific research scholars and casual visitors. As a result, Braun had to hastily extend the opening hours of the Gardens to accommodate approximately 5,000 visitors per day. However, entrance to the glasshouse was strictly controlled. Visitors could only enter under supervision, during set times, and had to leave their bags and coats at the entrance (Lack, 2004). While the achievements of Herrenhausen and Schöneberg were undoubtedly remarkable, they were not the first sites to bloom *Victoria regia* in Continental Europe. This honour belonged to the van Houtte Nursery, owned by Belgian Louis Benoit van Houtte, which bloomed *Victoria regia* on 5 September 1850 (van Houtte, 1850-1).

Van Houtte was best known as being the part proprietor of the van Houtte Nursery located in Gentbrugge, near Ghent in Belgium, and as the editor of the journal *Flore des Serres et des Jardins de l'Europe* (*Flowers of the Greenhouses and Gardens of Europe)*. Reportedly, van Houtte, in the mid-19th century, "…was burning with desire to be the first on the continent to cultivate *Victoria regia*" (Wittmack, 1894 p.226). Exactly why is somewhat unclear. However, it was likely due to his passion for botany and the commercial aspects of his nursery business. It could also be likely that he might have encountered *Victoria regia* or *Victoria cruziana*, or heard rumours of it, during his travels to South America during 1834-6.

Reportedly, van Houtte asked his head of plant cultures, Benedikt Rozel, to write to Ortgies and ask him to request a seeding of the *Victoria regia* from Paxton; Rozel had met Ortgies in London in 1848 (Wittmack, 1894). van Houtte also proposed (if Paxton consented) to employ Ortgies and make him the Head of the Culture of Aquatics and Orchids (Wittmack, 1894).

Even though Paxton was inundated with requests for seedlings of the *Victoria regia* and only four seeds had subsequently germinated, he agreed to van Houtte's request at once. On 26 May 1850, the *Victoria regia* arrived in Gentbrugge (van Houtte, 1850-1). While on 1 April 1850, Ortgies started his new position under van Houtte, and a *Victoria regia* house (Figure 69) was built according to Ortgies' plans (Wittmack, 1894). In addition to being the first to bloom the *Victoria regia* lily in Continental Europe, the van Houtte Nursery was also the first to construct a spherically formed *Victoria regia* glasshouse (van Houtte, 1850-1).

Ortgies' *Victoria regia* glasshouse had a diameter of 11.03 metres, and a circumference of 35.3 metres. The exterior walls were 1.05 metres high and supported an iron structure of curved, wrought iron for the glazed elliptical dome, which, in turn, was crowned with an octagonal lantern. The glasshouse's tank for the *Victoria regia* was 8.2 metres in diameter, with a deeper central portion that was 1.8 metres deep. The tank held 40 cubic metres of water and was surrounded by a passage that was 0.9 metres wide. The glasshouse was heated through a series of iron tubes placed below the walkway and the bottom of the tank. Furthermore, water movement was achieved by a small waterwheel placed below a cascade that was created by the hot water supply to the tank (van Houtte, 1850-1).

Considering Ortgies' earlier employment with Paxton at Chatsworth, and his undoubted familiarity with the developments at both Syon and Kew, it would be logical to assume that Ortgies' *Victoria regia* glasshouse would have adopted a similar regular, cuboid form. This was clearly not the case. The spherical form of Ortgies' *Victoria regia* glasshouse is explained by an investigation into the above-mentioned 1822 aquarium of J.C. Loudon. Recall that Loudon proposed that the "…Accumulated Semi-globe…" was indisputably the most perfect form for a glasshouse because plants would have almost equal access to sunlight in the glasshouse as those placed outside (Loudon, 1822 p.357). With specific reference to the cuboid-formed aquarium at Whiteknights, Loudon further proposed that while this span-roofed form was well suited to aquatic plants that “grow to some height above the water; it was not so for those plants whose leaves floated on its surface” (Loudon, 1822). As such, Loudon then proposed a circular glasshouse, with glass on all sides, as the “…most elegant plan…” for an aquarium (Loudon, 1822 p.927).

Loudon argued that his aquarium should contain a cistern at the centre for river plants, surrounded by a pathway. Surrounding the pathway would be a further outer circular cistern for those plants that grew in “…stagnant water…” (Loudon, 1822 p.927). Loudon’s plan was ‘elegant’ because of numerous factors first explained in his earlier concept of the ‘Accumulated Semi-globe’; the spherical dome over Loudon’s aquarium first sloped low over the cisterns at approximately 15° and was then gathered at the centre in a ‘accumulated apex’. This form allowed both the ‘floating leaves’ in the outer cistern, and those plants that grew ‘to some height above the water’ in the central cistern, equal exposure to the same amount of sunlight. According to Loudon, the ‘accumulated apex’ is necessary to allow for the exclusion of rain (Loudon, 1822). Additionally, Loudon’s aquarium was notable for the presence of a large basement containing machinery that was positioned below the central cistern. This machinery agitated the water of the central cistern to “…imitate the effect of the motion of water…” (Loudon, 1822 p.927).

Considering that Ortgies was responsible for the day-to-day care of the Chatsworth *Victoria regia*, he must have also been intimately aware of the lighting benefits Paxton’s ridge-and-furrow system supplied to the lily. Additionally, Ortgies could have known of Paxton’s intention to file a patent for the ridge-and-furrow system, and appeared to leave Paxton’s employ on very amicable grounds. These reasons could thus have negated the use of a ridge-and-furrow roof in the *Victoria regia* glasshouse designed by Ortgies. It is also highly likely that Ortgies was aware of Loudon and W. & D. Bailey’s commissions that were described above. Furthermore, it is proposed that Ortgies must have known of Loudon’s writings about the ‘Accumulated Semi-globe’ and aquarium, including the proposed lighting benefits for the *Victoria regia*. These factors could have influenced Ortgies’ choice for a spherically formed *Victoria regia* glasshouse. As such, it seems that Ortgies adapted the better-suited Loudon aquarium to the specific requirements of the *Victoria regia*. In Ortgies' glasshouse, the floating leaves of the *Victoria regia* were contained in the central pond. As such, the need for a higher central dome to accommodate plants that grew 'to some height above the water' was negated. This in turn also negated the need for a steep 'accumulated apex'. Ortgies' design also departed from the Loudon prototype in the functioning of the 'accumulated apex'. No longer was it only for the exclusion of water; now it was primarily intended for ventilation. As already stated, poor ventilation was one of the primary reasons for the failure of the 1852 Kew *Victoria regia* glasshouse. Therefore, it could be assumed that poor ventilation was common to the cuboid form. The Ortgies glasshouse also replaced Loudon's machinery basement with a deeper central portion to the central cistern; a concept already established by all prior *Victoria regia* glasshouses.

An alternative explanation could also hold true. The leaves of the first Chatsworth *Victoria regia* started at approximately 0.15 metres and after only three-and-a-half months, on 13 November, had reached a maximum size of 1.49 metres (Lindley, 1849). By comparison, after three-and-a-half months, the largest leaf of the van Houtte *Victoria regia*, which also started at 0.15 metres (on 1 May 1850), measured only 1.25 metres (van Houtte, 1850-1). Interestingly, on 1 October 1849, Paxton wrote to the Duke of Devonshire saying that the weather had 'set in' and turned wet and cloudy; on this date, the largest leaf diameter was recorded as having reached 1.22 metres (Flanders-Darby, 2002). Despite the inclement weather, the leaves of the Chatsworth lily continued to grow. If assessed on leaf growth and size alone, then clearly the Chatsworth was the healthier of the two lilies, that is, it received more sunlight and was more vigorous. Could this have meant that the ridge-and-furrow system was better at sunlight collection than the spherically formed glasshouse? If this is indeed correct, then, from a botanical cultivation perspective, the use of a spherical *Victoria regia* glasshouse would make less sense. What ultimately emerges from the above discussion is that, while Ortgies and van

Houtte were both very interested in *Victoria regia*, their motives were somewhat different. To illustrate this, it is worth exploring their histories in a bit more detail.

In 1876, when van Houtte died, he was described as a workaholic, having spent most of his time in his nursery office; he had apparently not been through his nursery grounds for almost three years (G. Johnson & Hogg, 1876). Cultivating the *Victoria regia* was not listed as among his main achievements, but rather his work for *Flore des Serres et des Jardins de l'Europe* and his endeavours in cultivating gloxinias and camellias were. Furthermore, the successful economic aspects of the nursery were praised: “Mr Van Houtte has left behind him a rare example of industry” (G. Johnson & Hogg, 1876 p.389-90). After van Houtte’s return to Ghent in 1839, he was formative in founding one of Belgium’s two gardening schools (*Tuinbouwscholen*) in 1849. The other school was located at Vilvorde, and was under the directorship of Laurent de Bavay (*E’cole D’horticulture Pratique a Vilvorde*). van Houtte’s school was located at Gentbrugge (Parent, 1850). In addition to *Flore des Serres et des Jardins de l'Europe*, van Houtte, in collaboration with Charles Francois Antoine Morren, also founded the publication *L'Horticulture Belge (Belgium Horticulture)* (Morren, 1833-8). Furthermore, van Houtte was elected as the Mayor of Gentbrugge because of his business acumen, flair for languages and botanical knowledge (G. Johnson & Hogg, 1876). Van Houtte was said to have prided himself on retaining and rewarding ‘good’ men (G. Johnson & Hogg, 1876). Ortgies was undoubtedly one of these men.

Before joining Paxton at Chatsworth, Ortgies had started a gardening apprenticeship with H. Böckmannn in Hamburg on 1 May 1844. After three years in Hamburg, Ortgies visited certain renowned nurseries in Berlin, Dresden, Leipzig, Magdeburg and Potsdam. On 1 March 1848, he became employed at the A. Henderson and Co. Pineapple Place Nursery in London. In the spring of 1851, Ortgies was placed in charge of German and English correspondence and the preparation of catalogues, and was then transferred to the offices of the van Houtte Nursery. But, refusing to become totally office bound, Ortgies remained as the Head of the Culture of Aquatics and Orchids. In this new role, Ortgies successfully cultivated from seed and later bloomed *Nymphaea gigantean*, while additionally creating the hybrid *Nymphaea Ortgiesiano-rubra*. In 1855, Ortgies reluctantly left the employ of the van Houtte Nursery (Wittmack, 1894) when he was appointed as the Chief Gardener of the Zurich Botanical Gardens. The above represents a narrative of an enthusiastic man, who, while undoubtedly talented at administration, management and leadership, was additionally first and foremost a 'hands-on' gardener.

Figure 70 Johann Borsig's 1851 *Victoria regia* glasshouse, indicated by the dashed lines at the bottom right of the image (Image: www.commons.wikimedia.org).

Having described the two men, it seems clear that their motives for cultivating the *Victoria regia* were different; while Ortgies was interested in literally cultivating it, van Houtte was more interested in financially cultivating it. Indeed, the van Houtte nursery was unquestionably interested in the cultivation of *Victoria regia* for its commercial potential. In the best traditions of marketing, a highly desirable product is nothing without adverting and display. The economic potential of the *Victoria regia* could well have resulted in van Houtte packaging the lily in a glasshouse that used those most modern materials of glass and iron, along with a very contemporary spherical aesthetic. The referencing of another spherically formed *Victoria regia* glasshouse will develop this argument further.

After van Houtte's Nursery, the next to bloom *Victoria regia* in Continental Europe was the Botanical Gardens at Herrenhausen, on 29 June 1851. This was followed by the Botanical Gardens of Hamburg in 1851 (Hochstetter, 1852), and Berlin (Schöneberg) on 22 July 1852 (Lack, 2004). Three days prior to the latter (i.e., 19 July 1852), the previously mentioned industrialist Johann Borsig bloomed his *Victoria regia* at his Moabit Villa in Berlin (Hinckeldeyn & Sarrazin, 1883). In 1851, Borsig instructed the engineers who worked at his famous *Borsig Werke* (Borsig Works) to design and construct a glasshouse for the *Victoria regia* (Figure 70). This glasshouse was described as a detached iron-and-glass structure that had a glazed dome that was heated with water from the nearby Borsig Works (Lack, 2004). Alternatively, the glasshouse was described as an elegant glass temple construction of dainty iron rods (www.bgbm.org, 2010). Planted on 9 May 1852 and flowering two months later, the *Victoria regia*, in its new *Glaspalast* (Glass palace), transformed the formerly tranquil Borsig Gardens. From this point onward, the Borsig Gardens became a major Berlin attraction (Wittmack, 1894). By the end of 1852, the lily was additionally found at Tübingen, Leipzig, Dresden, Bonn, Stuttgart, Karlsruhe, Konstanz, and at The Botanical Gardens at Schönbrunn in Vienna (Hochstetter, 1852).

In many ways, Borsig was very similar to van Houtte. Prussia, in the first half of the 19th century, set itself on a course of industrialisation. Through prominent personalities, such as Peter Beuth, Karl Schinkel and Peter Lenné, Prussia sought to mirror the very best of British industrialisation—its material wealth, freedoms and national power—without its faults; i.e. pollution and disease. Prussia would rather have an aestheticized version of industrial society (Thompson & Galison, 1999). As such, in 1821, a new institution, the *Preußische Gewerbeförderung* (Trade Promotion Institute of Prussia) was established (Baumol, Mokyr, & Landes, 2010). In the early part of the 19th century, Prussia was almost totally dependent on, mostly British, imported precision tools and machinery—importantly, steam engines (Wise, 1995). Thus, along with the *Gewerbeförderung*, numerous *Gewerbeschule* (Trade Schools) were established, including Beuth's in Berlin. At the Berlin *Gewerbeschule*, British machinery was illegally imported and carefully studied, with the ultimate aim of copying the machinery and manufacturing clones in Prussia (Kitchen, 1978). Borsig was one of the Berlin *Gewerbeschule*'s prominent pupils (Wise, 1995). Initially, Borsig was trained as a carpenter, but, having attended the *Gewerbeschule,* he quickly established his reputation as a master mechanic (James. J Sheehan, 1989). With the aid of Prussian government subsidies, in 1837, Borsig established a steam-engine manufacturing business in Berlin. Initially, the Borsig factory supplied steam engines for sugar beet refining, but in 1841 produced its first locomotive based on an American design. By 1848, Borsig was in a position to supply the entire demand of the Prussian railways, and, by 1854, had produced some 500 locomotives (Biesinger, 2006).

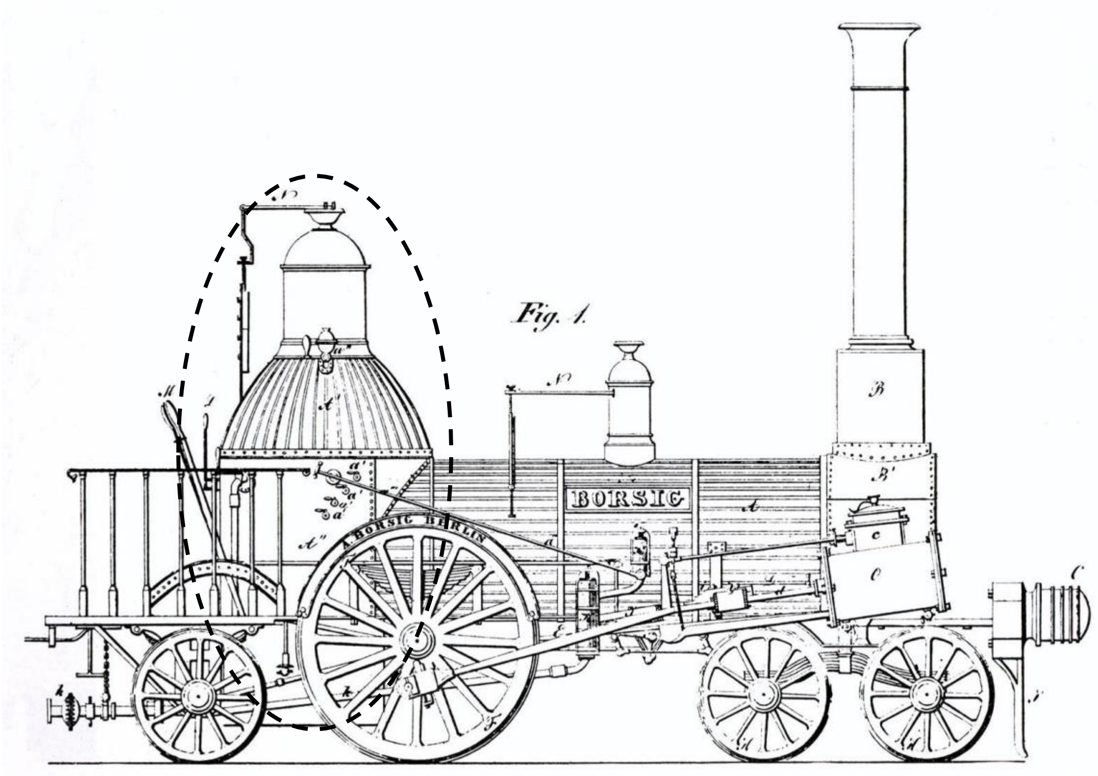
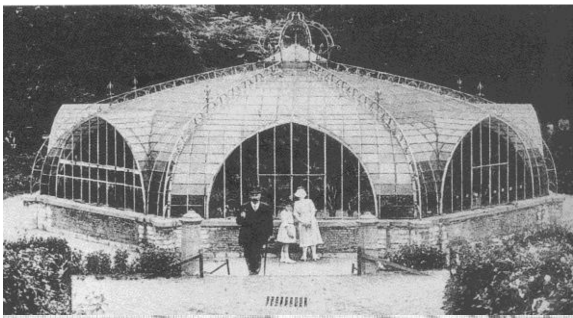
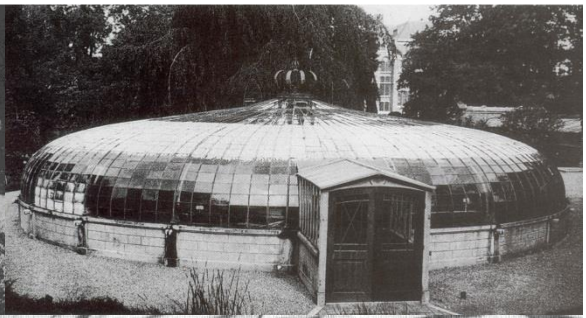


Figure 71 The *Beuth* locomotive with the steam-dome and firebox indicated by the dashed lines (Image: www.commons.wikimedia.org).

The neoclassical Borsig Villa was built in the new industrial Berlin suburb of Moabit. Separating the Villa from the adjacent Borsig Works was a park design by Lenné. As stated above, adjoining the Villa, in a manner typical of private winter gardens, was a cast-iron glazed glasshouse in the form of a masonry colonnaded hall, with skylights and large window openings. This winter garden was directly accessible from the Villa via the salon and living room. Adjoining this winter garden





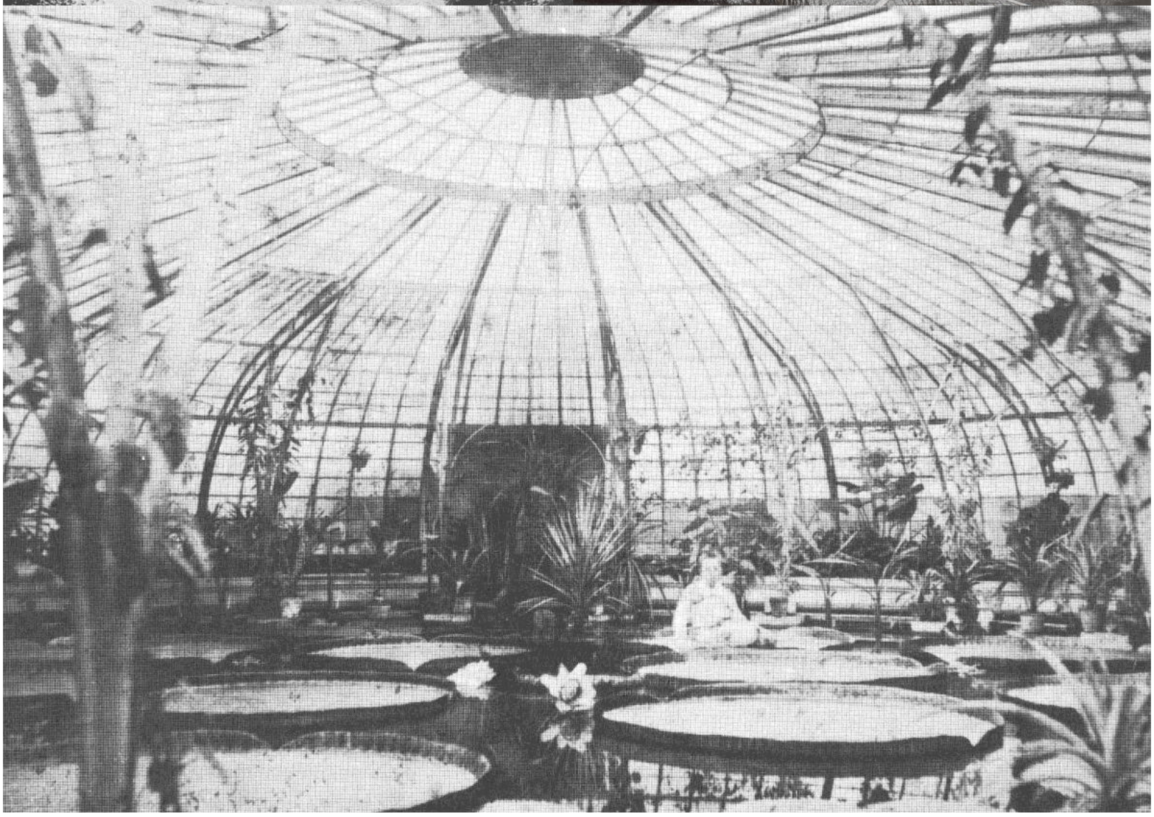


Figure 72 Top left - Alphonse Balat's 1853 *Victoria regia* glasshouse (Image: Hix, 2005).
Figure 73 Top right and bottom – 1870 *Victoria regia* glasshouse at the University of Leiden (Image: Hix, 2005).

was a long, lean-to, cast-iron-framed forcing house, which opened out onto the garden. The roof of the forcing house was constructed according to the ridge-and-furrow principle and the front elevation comprised a series of thin cast-iron columns that had a highly ornate cast-iron frieze. Both of these glasshouses were constructed from components made in the Borsig Works. A separate, large cubic-shaped palm house was additionally located in the garden. This structure had lean-to ends and was apparently similar to the Great Palm House at the Berlin Botanical Gardens (1857–79) at Schöneberg (Kohlmaier & von Sartory, 1986). The glasshouses were heated by waste hot water from the Borsig factories. This hot water was also drained into open-air ponds in the garden, which contained numerous gold fish and hybrid *Nymphaea,* developed by Carl Bouche in 1852–53. The sight of these open air ponds, with their exotic inhabitants, was unique to Europe and England; it created a surreal impression of being on the banks of the Rivers Nile or Ganges (Koch, 1857). The *Victoria regia* glasshouse was built in close proximity to these ponds, at the end of the garden, near the banks of the River Spree. The possession, cultivation and public display of rare botanical specimens in technologically advanced glasshouses meant that the Borsig Gardens became part of what would today be termed 'public relations' (Kohlmaier & von Sartory, 1986). Admission fees to the Borsig Gardens formed the basis of a disability fund for the Borsig Works employees. This fee also allowed the visitor to enter the *Victoria regia* glasshouse.

Borsig's intentions in constructing his *Victoria regia* glasshouse were not purely intellectual curiosity; he too was interested in profit and advertising. Moreover, Borsig was not only motivated by horticultural ambition; this new glasshouse was additionally intended as a technical prototype. Indeed, if the glasshouse was a success, it could have been used to expose the public to current or intended products of the Borsig Works, i.e. glasshouses, fountains and irrigation equipment (Lack, 2004). Considering this statement, Borsig's *Victoria regia* glasshouse could also have been an extremely powerful commercial symbol for the product that Borsig was most famous for during the 1840s: steam locomotives—in particular, the *Beuth* (Figure 71). One of the prominent features of the *Beuth* locomotive was the large steam-dome located above the firebox. The purpose of the steam-dome is twofold: it collected dry or superheated steam and then directed the steam into a Steam-funnel/pipe and then onward into the driving mechanism. In turn, the steam-funnel/pipe was projected into the interior of the steam-dome. This kept the top of the steam-funnel well above the water level of the boiler, and prevented the water from entering the driving mechanism. Analogies are immediately apparent: the spherical *Beuth*'s steam-dome could be equated with the hot and humid glazed spherical dome of the *Victoria regia* glasshouse; the steam-funnel could be the central cistern containing the *Victoria regia*, raising the lily above the water level. This analogy is even more pertinent considering the fact that Borsig instructed his engineers—who were first and foremost locomotive engineers—to design the *Victoria regia* glasshouse.

Both the van Houtte and Borsig *Victoria regia* glasshouses established a prototype that was distinct from earlier, mainly British, examples that were regular in plan and cuboid in form. While both borrowed the planning and central location of the cistern from the earlier British examples, they established an overall spherical form that supposedly derived from Loudon's pioneering work. Additionally, these two glasshouses used the then advanced technology of a self-supporting iron frame. The use of curved glazing, in comparison to regular flat planes, was also more expensive to manufacture (Koppelkamm, 1981). Therefore, the spherical glasshouse had an added aura of opulence. It is further proposed that the smooth spherical form of their glasshouses not only suited the botanic needs of the *Victoria regia*, but also satisfied the very important need for promotion and publicity. In turn, the procession and cultivation of the *Victoria regia*, displayed in a technologically, aesthetically advanced and opulent glasshouse, became an item to aid consumerism. From about 1860, most subsequent *Victoria regia* glasshouses were executed according to the circular or polygonal plan, which were covered by flattish curved glazed domes (Kohlmaier & von Sartory, 1986). The setting of the dome low over the central basin was intended to facilitate the economical heating of the interior (Koppelkamm, 1981).

3.14 Further examples of Continental European *Victoria regia* glasshouses

The polygonal plan was apparently first used in Europe by Alphonse Balat in 1853 (Goedleven, 1997). Balat's *Victoria regia* glasshouse (Figure 72) was initially located at the old Brussels Zoo, the present site of the Leopold Park. From the corners of an elegant octagonal plan that measured 46 feet in diameter, curved iron trusses mounted on low stone walls extended upwards and culminated in a decorative crown (Hix, 2005). Supposedly, because of this crown the glasshouse was known as *Kroonserre* (Crown Glasshouse). The structural trusses were placed on the outside of the glazed skin; supposedly solving the problem of cold condensation droplets that could have fallen onto and harmed the interior foliage (Koppelkamm, 1981). An additional aesthetic intention was also implied through the use of ornamental braced trusses and the wrought-iron ribs (Kohlmaier & von Sartory, 1986). The exposed truss structure of Balat's glasshouse was the largest glazed structure of its type in Europe in 1853 (Lack, 2004). As such, Balat's exterior use of structure predated the large structures of Laeken by 20 years, Schönbrunn by 30 years, and Dahlem by 50 years.

A further example of a spherically formed *Victoria regia* glasshouse (Figure 73) was constructed at the Botanical Gardens of the University of Leiden in 1870 (Hix, 2005). Here, the *Victoria regia* bloomed for the first time on 8 July 1872, an event to which nearly 30,000 people came to marvel (Hix, 2005).

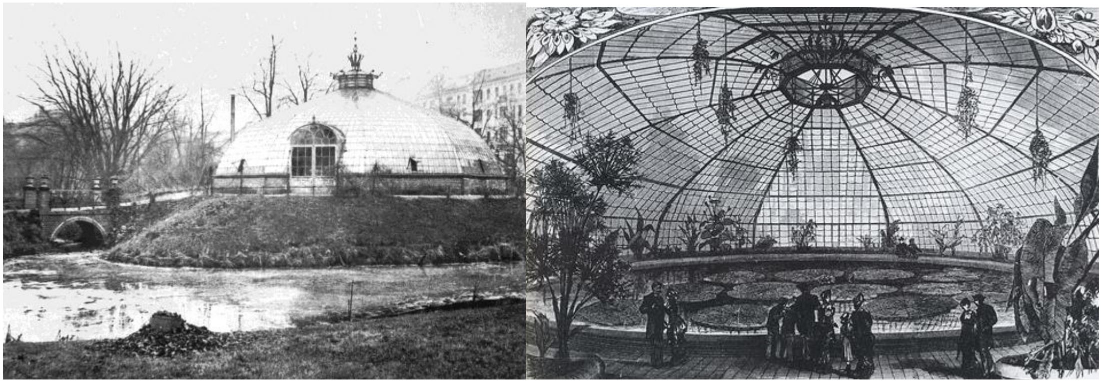
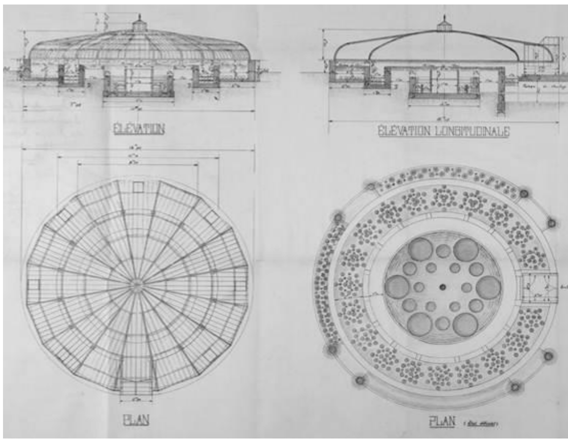


Figure 74 The 1883 *Victoria regia* glasshouse at the Berlin Botanical Gardens, Schöneberg (Images: left -www.bildindex.de; right -www.commons.wikimedia.org).

In 1883, the old wooden *Victoria regia* glasshouse at the Berlin Botanical Gardens, Schöneberg, was replaced. This was because of its dilapidated condition, but also because it did not confirm to the aesthetic standards for current *Victoria regia* glasshouses, which were by then established in Dutch, Belgian and English botanical gardens (Lack, 2004). In the planning of the replacement *Victoria regia* glasshouse (Figure 74), Prof. A.W. Eichler, as the then Director of the Gardens emphasised the need for a prestigious and magnificent building. The result was a building planned on a decagon containing a central cistern for the lily. Rising above the masonry decagon base was a flat iron and glazed dome, which terminated at the apex in a ventilation lantern (Lack, 2004).

The use of *Tausende von Glasschuppen* (thousands of glass flakes/plates) created an extraordinary interior effect in the new Schöneberg *Victoria regia* glasshouse, or *Glaspalastes* (Glass Palace) (Lack, 2004). This 1883 *Victoria regia* glasshouse was intended to have a distinct analogy with the lily: the structure of the dome, with its radiating purlins that were in-filled with thousands of small glass plates, was clearly a comparison to the underside of the *Victoria regia*'s leaf structure (Lack, 2004). In a description of his new glasshouse, the designer F. Schultze made no such comparison (Schultze, 1883). However, Schultze (1883) did mention that the *Victoria regia* formed the central attraction of the botanical gardens. He (1883) also contended that ever since its initial blooming in 1852, large crowds continually flocked to the Schöneberg gardens to see the annual blooming of the lily. As such, he argued, the time was right to construct a new *Victoria regia* glasshouse that would correspond in both size and shape to those that had been built in major European cities during the previous 10 years (Schultze, 1883). The new Schöneberg *Victoria regia* glasshouse's regular decagon had an outside diameter of 16.25 metres. A large central tank of 8.5 metres in diameter was centrally located that had a 1-metre-deep central portion for the lily, while the outer extremities of the tank were only 0.3 metres deep. Surrounding the central



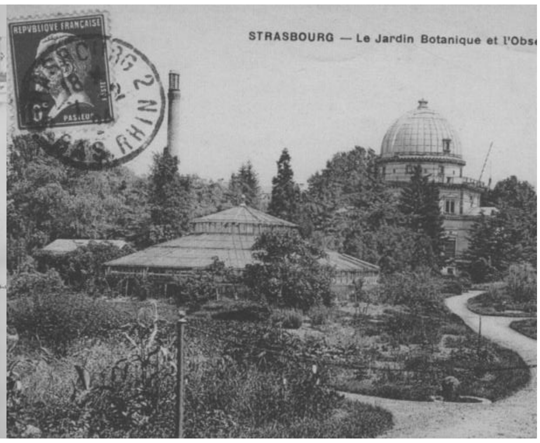


Figure 75 Left - The 1888 *Victoria regia* glasshouse, Lyon (Image: www.jardin-botanique-lyon.com).
Figure 76 Right - The 1884 *Victoria regia* glasshouse, Strasbourg Botanical Gardens (Image: Anisko, 2013).

tank was a circular shaped pathway that was 1.5 metres wide. Likewise, a further circular tank, intended for other aquatics and also 1.5 metres wide, surrounded the pathway. Furthermore, the external masonry walls were 0.51 metres thick and supported the glazed dome. Crowning the glazed dome was an ornate ventilation lantern that was in-filled with venetian-vent panels and capped with an elaborate iron crown. The glasshouse was heated through a system of closed copper pipes.

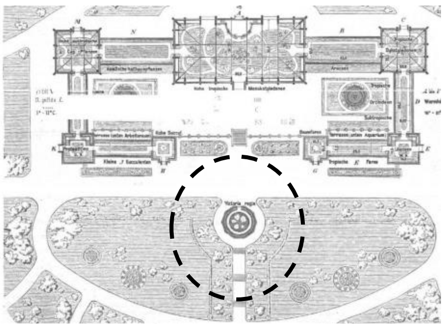
Schultze was also at pains to claim that if the Berlin Botanical Gardens was to rise in rank and prestige through the construction of facilities such as the new *Victoria regia* glasshouse, then continued financial support would be required from donors so that the Gardens could be comparable to the very best in Europe (Schultze, 1883).

The aims of the Berlin Botanical Gardens were apparently not unique. On 17 March 1887, the Lyon City Council decried the fact that, while most European cities had a glasshouse dedicated to *Victoria regia*, their city did not. Thus, in 1888, a *Victoria regia* glasshouse (Figure 75) was constructed according to the plans of M. Oddos, who was the city's Chief Engineer of Roads and Water. This relatively small spherically formed building had a central cistern for the lily that was 7.9 metres in diameter, and surrounded by a 1-metre-wide pathway. This glasshouse, like that at Leiden, had a prominent double-door entrance 'airlock'. Additionally, it also had a simple ventilation lantern at the apex of the glazed dome. *Victoria regia* flowered for the first time on 14 June 1894 in this newly constructed glasshouse. In 1929, the glasshouse was renovated, and a circular basin was added to the outside of the walkway, and the dome structure and cladding were totally remodelled. Even though this design conformed to the already established prototypes, like that at the Berlin Botanical Gardens of 1883, it was unique in France even as late as 1929 (www.jardin-botanique-lyon.com).

A further example of a *Victoria regia* glasshouse (Figure 76) was located at the Strasbourg Botanical Gardens. It was inaugurated in 1884 and designed by Georg Peter Hermann Eggert. The plan consisted of a 12-sided regular polygonal that measured 12 metres in diameter. A circular cistern, which measured 7 metres in diameter and was 0.5 metres deep, was located at the centre of this plan for the *Victoria regia*. A further deeper portion of 0.5 metres was provided at the centre of the cistern. The central cistern was, in turn, surrounded by a circular pathway that was 0.96 metres wide. Surrounding the pathway was a further outer cistern that was 0.71 metres wide. The entrance to the glasshouse consisted of a prominent double-door 'airlock' structure clad in stone, with the boiler room and flue located directly opposite. The glasshouse additionally had a regular iron structure, which rose from low walls (Eggert, 1888). Likewise, in 1888, a *Victoria regia* glasshouse was added to the Copenhagen Botanical Gardens. Located to the east of the 1872 palm house, this glasshouse consisted of a plan that was a regular 24-sided polygon. The Copenhagen *Victoria regia* glasshouse had relatively steep sloping glazing, which was undoubtedly necessitated by the need to shed show during the Scandinavian winter.

3.15 The Berlin Botanical Gardens relocated to Dahlem

By 1888, the spread of tenements (*Mietskasernen*) had rapidly surrounded the Berlin Botanical Gardens, Schöneberg, and was literally choking the air from the Gardens. By this time, many of the existing glasshouses were in poor condition, and the Gardens were without a Director (Lack, 2004). Within this context, the Assistant Director of the Berlin Botanical Gardens, Ignatz Urban, proposed that the Gardens should be relocated to a new 40-hectare site in the Berlin suburb of Dahlem. Initially, the new Director, Prof. Adolf Engler, appointed in 1889, was sceptical of these proposed relocation plans. Apart from the potential loss of valuable botanic specimens, Engler also feared that the proposed move would additionally create a physical dislocation between the Gardens and the Berlin city centre. Despite these reservations, on 26 June 1897, a new law formally relocated the Berlin Botanical



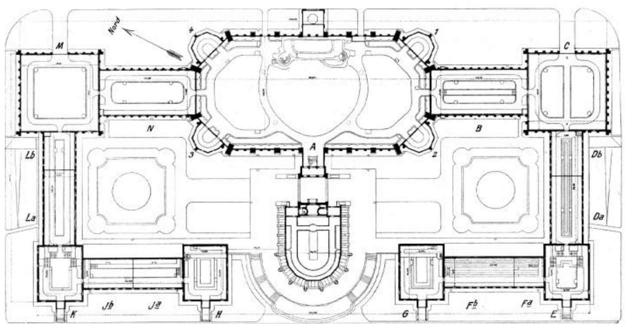


Figure 77 Left - The initial 1895 proposal for the new glasshouse complex at Dahlem. The relocated *Victoria regia* house is indicated by the dashed lines (Image: Sarrazin & Hofsfeld, 1897).
Figure 78 Right – The Dahlem glasshouse complex as constructed in 1909 (Image: Sarrazin & Schultze, 1909).

Gardens to Dahlem, and 4 million German marks were provided for the new gardens and structures (Lack, 2004). The architect Alfred Korner, together with the landscape architect Axel Fintelmann, began the design of the new gardens.

On 24 May 1910, Engler, along with botanists from around the world, celebrated the official opening of the Berlin Botanical Garden at Dahlem. Engler, who had previously visited a number of other botanical gardens, initially proposed an axial-designed glasshouse complex that followed the design of the glasshouses he had encountered—a large central palm house with a smaller spherical glasshouse (*kugelförmigen Eckbau*) located on either side of it (Lack, 2004). This description of Engler's design proposal is undoubtedly reminiscent of examples such as the palm houses of Kew and Belfast. In contrast, Korner, who was commissioned by the Ministry of Public Works, in his first sketch designs that were first published in 1895, proposed a much larger rectangular or 'C' shaped glasshouse complex (Figure 77). Interestingly, in this 1895 plan, the *Victoria regia* glasshouse was not yet part of the central glasshouse complex; Korner, instead, proposed that the relatively new 1883 Schöneberg *Victoria regia* glasshouse be relocated to Dahlem. In the spring of 1899, Engler decided to integrate the *Victoria regia* glasshouse into the centre of the 'C' shaped glasshouse complex (Figure 78). This development followed the advice given by Director Siebert of the Frankfurt *Flora*. In 1905, the *Victoria regia* glasshouse was formally incorporated into the main glasshouse complex that was considered a masterpiece of engineering and was equipped with the very latest in technology, like electric lighting, water humidifiers, and electrically operated vents. The heating of the new glasshouse complex was accomplished by four boilers that circulated steam in iron pipes to the individual glasshouses. Consequently, in the summer of 1910, the first Dahlem *Victoria regia* was brought to bloom in the newly constructed glasshouse (Lack, 2004). The design of the Dahlem glasshouse complex was undoubtedly influenced by the wider tendency towards such large, centrally located installations.

In 1905, the Frankfurt Botanical Gardens constructed a new glasshouse complex. Unlike Dahlem's 'C' planning, Frankfurt was designed as a 'solid' rectangular planned complex of glasshouses that were centred around a large central palm house with two smaller wings to the left and right. Contained within this complex was a span roofed glasshouse for the *Victoria regia* (Sarrazin & Schultze, 1907). At approximately the same time as Frankfurt, similar 'solid' rectangular planned complexes of glasshouses were additionally constructed in the Munich suburb of Nymphenburg.

Figure 79 The Phipps Conservatory in Schenley Park, Pittsburgh (Image: www.phipps.conservatory.org).

Apart from these German examples, the American glasshouse complexes at New York and San Francisco can be considered as examples of the tendency toward large, centrally planned glasshouse complexes. The glasshouse, complex or Phipps Conservatory (Figure 79), at the Philadelphia Botanical Gardens is also of interest. In the later decades of the 19th century, the eastern Pittsburgh suburb Oakland was considered the richest neighbourhood in the world. Oakland, alternatively known as the East End was home to prominent industrialists and armature botanists like Henry Frick, Henry Heinz and Henry Phipps. As a result of these and other individuals' immense wealth, the East End predictably contained many large gardens and glasshouses. In these settings, Frick cultivated outstanding roses and orchids and was an acknowledged expert on growing mushrooms. Heinz, in turn, nurtured pansies and chrysanthemums in a garden that rivalled Versailles. As the East End's glasshouses contained many exotic flowers and trees, they were open to the public during the weekends. As a result of this public interest, in 1893, Phipps financed the construction of the Phipps Conservatory (Skrabec, 2010). Phipps was a business partner and childhood friend of Andrew Carnegie. Both of them were deeply involved in steel production (Skrabec, 2010), but Phipps' fortune additionally came from speculation in real estate (Squirrel Hill Historical Society, 2005). The

Phipps Conservatory was constructed by the firm Lord and Burnham and consisted of nine display glasshouses that had 'silvered' glazed vaults (Squirrel Hill Historical Society, 2005). As the prominent glasshouse contractor of its time, Lord and Burnham were also responsible for the glasshouse complex in New York. Both the glasshouse complexes at New York and Philadelphia had similar Victorian aesthetics. Interestingly, Lord and Burnham pioneered curvilinear iron framed glasshouses in the United States of America, with the 1881 construction of the glasshouse complex for the railroad magnate Jay Gould at his Lyndhurst Estate (Kohlmaier & von Sartory, 1986). In its day, this glasshouse complex was the largest in the United States of America (Renehan, 2008). On opening, the Phipps Conservatory featured a large collection of tropical plants from the 1893 World's Colombian Exposition in Chicago (Squirrel Hill Historical Society, 2005). Interestingly, the *Victoria regia* was displayed in numerous locations at the World's Colombian Exposition. The first display was located in an open air pond between the glazed dome of the Horticulture Building and the artificial lagoon (Hays, Chandler, & Crane, 1892; Igleheart & White, 1893). The second was located inside the Horticulture Building, in the south court which contained a wine cellar from the Rhine area in Germany. Here the *Victoria regia* was located in several artificially heated basins with other aquatic plants (Handy, 1893). Likewise, as early as 1895, the *Victoria regia* was also on display at the Phipps Conservatory (Skrabec, 2010).

3.16 Conclusion

This detailed analysis of glasshouses seeks to propose alternative explanations for the origins of Bruno Taut's *Glashaus*. It has been shown that these can be found within the affinities that the *Glashaus* shared with the glasshouses constructed for the *Victoria regia* lily. Likewise, it has been shown that the *Victoria regia* glasshouses did not themselves evolve in isolation – they too had distinct similarities with earlier glasshouse precedents.

Hix (2005) has argued that glazed modern architecture was the result of almost 250 years of experimentation with horticultural glasshouses. A similar view is expressed by Kohlmaier and von Sartory (1986) when they stated that horticultural glasshouses prepared the way for modernist architecture. What is most significant about this last statement is that while the relationship between horticultural glasshouses and modernist architecture has been alluded to by numerous authors, such as Gideon (Giedion, 1928, 1976), Gloag & Bridgewater (1948), Hitchcock (1958), Henning-Schefeld & Schmidt-Thomsen (1972), Roisecco (1972), Pevsner (1976) and Benevolo (1978), it had yet to be "…systematically investigated and described" (Kohlmaier & von Sartory, 1986 p.5).

Two facts are immediately apparent if the *Glashaus* is considered in light of Kohlmaier and von Sartory's (1986) call for further investigation. First, the aesthetics of the *Glashaus* closely resembles that of certain horticultural glasshouses. Second, the *Glashaus* occupied an important junction between modernist architecture and preceding periods. The initial conclusion is that horticultural glasshouses were 'inspiration' for the *Glashaus*' design. However, two links are still required: the initial explicit linking of the horticultural glasshouse 'inspiration' to both the 'design' of the *Glashaus* and Taut's writings, and the deciphering of the 'poetics' inherent in Taut's writings.

The explicit linking of the horticultural glasshouse 'inspiration' to the 'design' of the *Glashaus* is possible. Accepting the argument that Scheerbart's role as overstated does not however totally dismiss his contribution. Scheerbart, apart from having an uncanny technical knowledge of modern materials and botanical glasshouse construction, also named specific glasshouses at the Berlin Botanical Gardens, Dahlem, in his 1914 publication *Glasarchitektur*.

As mentioned, the construction of the main glasshouse complex at the Berlin Botanical Gardens, Dahlem, began in 1907, and later officially opened in May 1910 (Lack, 2004). Taut returned to Berlin in 1908 to pursue further studies at the *Technische Hochschule* in Berlin-Charlottenburg, and subsequently opened his own Berlin office in 1909 (Hartmann et al., 2001; Junghanns, 1983). Taut's Berlin offices, which he shared with Franz Hoffmann, were initially located south-west of the city centre in *Linkstraße*, but later also in *Potsdamer Straße* (Junghanns, 1983). Both of these locations were within seven to eight kilometres of the new Berlin Botanical Gardens. Additionally, these two locations were also a mere three kilometres from the Borsig *Victoria regia* glasshouse and one to two kilometres from the location of

Figure 80 The *Victoria regia* glasshouse at the Berlin Botanical Gardens, Dahlem (Image: By author).

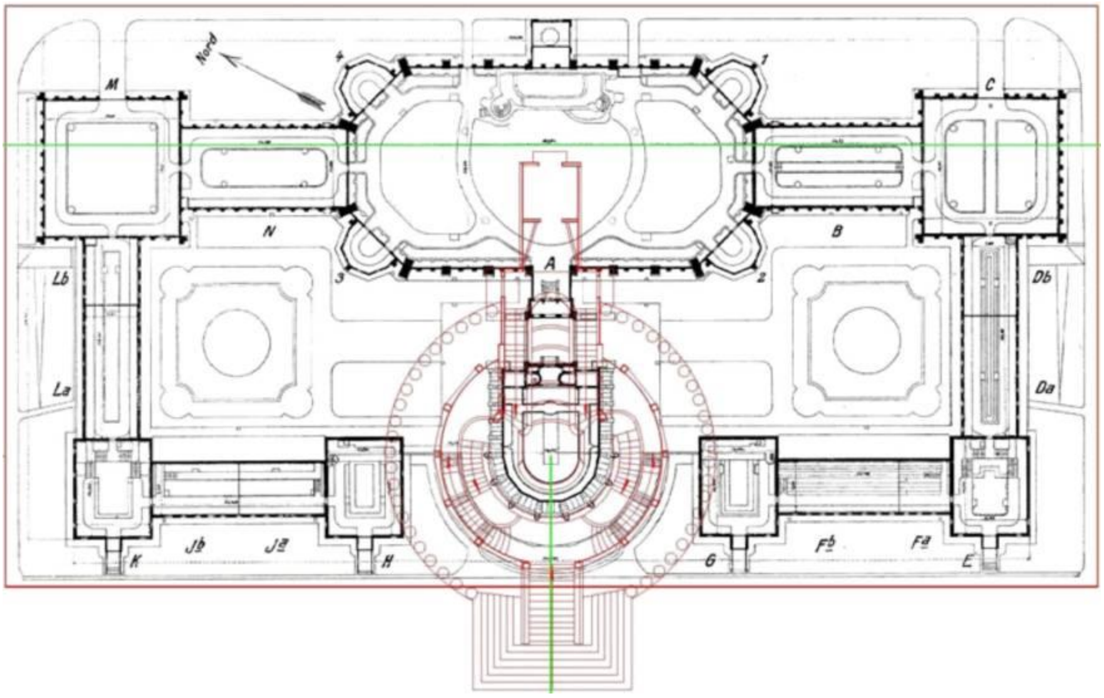


Figure 81 Overlaying the *Glashaus* plan (red) onto the plan of the *Victoria regia* glasshouse at the Berlin Botanical Gardens, Dahlem (black) (Image: By author after the orignal by www.commons.wikimedia.org).

the Old Berlin Botanical Gardens, Schöneberg. It is not known whether either the Borsig or Schöneberg *Victoria regia* glasshouses still existed in 1908. As mentioned above, Korner's 1895 plan for Dahlem considered incorporating the Schöneberg *Victoria regia* glasshouse, which was still at this stage 'relatively new'. Additionally, in the photo (Figure 70) of the Borsig Works that was taken around 1900, the Borsig *Victoria regia* glasshouse is visible. Thus, it is proposed that when Taut returned to

Berlin in 1908 both the Borsig and Schöneberg *Victoria regia* glasshouses still existed. But once again no documentary evidence can be found that directly links Taut with any of these. However, it is highly likely that Taut had direct knowledge of the glasshouse construction activity at Berlin Botanical Gardens, Dahlem, which, as explained above, contained a *Victoria regia* glasshouse at its very centre. A closer comparison between the *Victoria regia* (both from the perspective of the glasshouses built to cultivate it and from the lily itself) and Taut's *Glashaus* reveals startling and immediate similarities.

As stated above, from about 1860, most *Victoria regia* glasshouses were executed according to a circular or polygonal plan that were covered by flattish curved glazed domes. If regular cuboid-shaped *Victoria regia* glasshouses are excluded, it is clear from the argument presented above that initially, *Victoria regia* glasshouses had circular plans; e.g. the van Houtte/Ortgies (1850) and Borsig (1851) examples. It is also clear that polygonal plans emerged only later; e.g. the Balat (1854) example. In all of the examples presented above, the central component of the plan was always occupied by a large (nearly always circular) tank or cistern that accommodated the *Victoria regia*. Likewise, this central tank was, in most cases, surrounded by a pathway, which was further surrounded by a tank for smaller aquatic plants. The circular planned *Victoria regia* glasshouses can be directly connected to Loudon's conceptual aquarium (1822) and the pioneering smoothed curved glasshouses of W. & D. Bailey. When the plan of the *Glashaus* (Figure 1) is compared to that of the circular planned *Victoria regia* glasshouses, similarities are immediately apparent. The overall forms of both buildings were similar; outwardly, both were stand-alone pavilion type buildings, and both had a low squat solid base that contained the pools and mechanical equipment needed to maintain them. Both had a distinct entrance, which rose upwards through the base. The main features of both buildings were their glazed curved domes, which sprang from the base, that were highly faceted. Additionally, both domes had a 'lantern' or 'accumulated apex' at the top of the dome. However, the dome over the *Glashaus* was intended to shed rain, much like Loudon's 1822 proposal. Furthermore, both plans were based on regular polygon/circular arrangements, and both had a deeper central ‘pool’ to their designs. In the case of the *Glashaus*, the ‘pool’ could either have been the physical cascade or the oculus that connected the Dome Room to the Cascade Room below.

Certain aspects of the *Glashaus* are reminiscent of particular features of *Victoria regia* glasshouses. The dome of Taut’s *Glashaus* had a seemingly curious external diameter of 11.06 metres. However, when this number is considered within the context of the *Victoria regia*, it becomes apparent why Taut would have used it. As mentioned above, the van Houtte/Ortgies’ *Victoria regia* glasshouse of 1850 had an overall diameter of 11.03 metres, while Paxton’s *Victoria regia* glasshouse (1849–50) had a central tank that was 33 feet, or 10.06 metres, in diameter (Lindley, 1850). Likewise, The Exotic Nursery in Kings Road, Chelsea, had

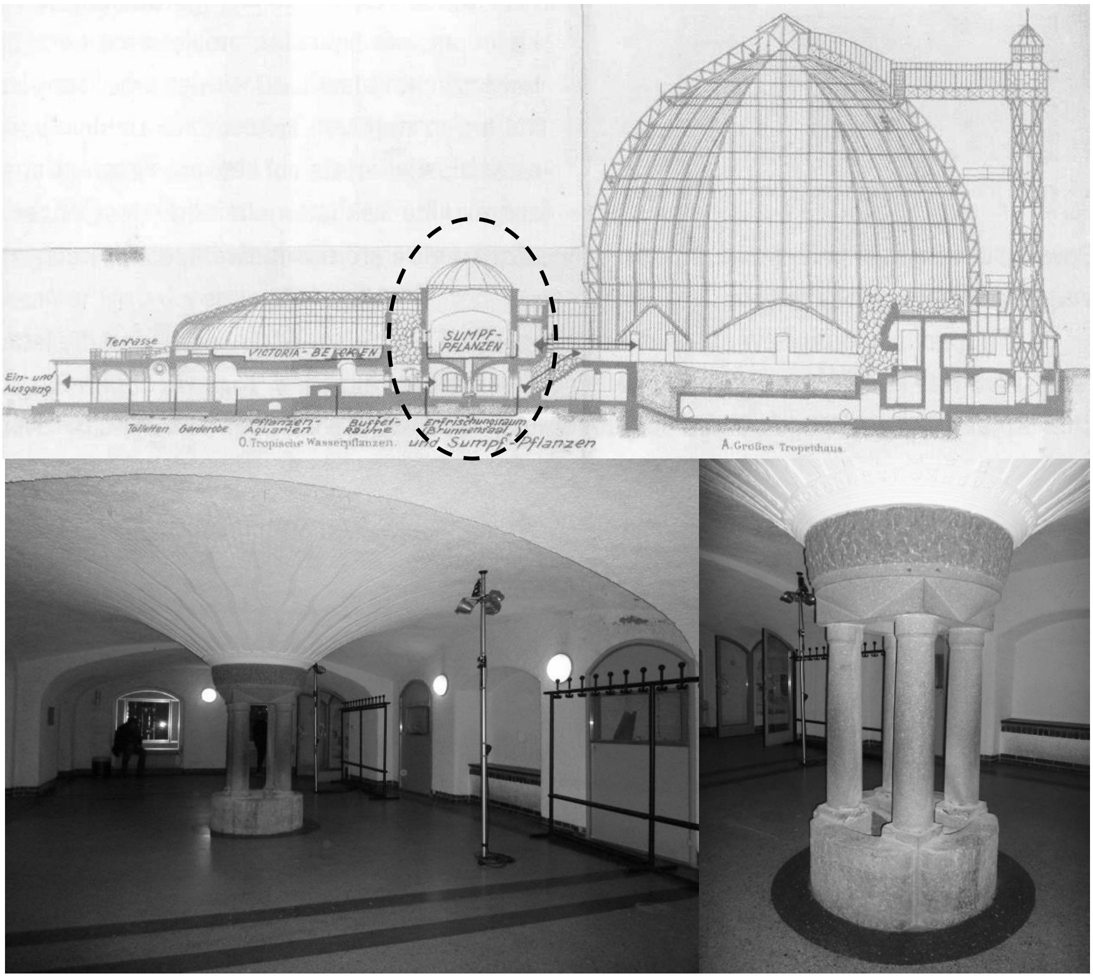


Figure 82 Top - A section through the greenhouse complex at the Berlin Botanical Gardens. The original *Sumpfplanzen* (Swampland) greenhouse with its glazed domed and the *Brunnensaal* (Fountain hall) below are indicated by the dashed line. The *Victoria regia* greenhouse is to the left of the image, with the grotto indicated below. Bottom – The *Brunnensaal* as it appeared in 2012. This appears to be the same as when it was originally constructed in 1909 (Images: Upper - Lack, 2004; Lower - By author).

small vases placed on the lip of the central tank, and pendant vases to the underside of the roof (as seen in Figure 66). Could these vases not be synonymous with the electric lights that hung in the interior of the *Glashaus'* dome room and the glazed spheres that surrounded the base of the *Glashaus*? Furthermore, the movement of the water, mostly through the use of a small waterwheel, has been identified above as a prominent feature of *Victoria regia* tanks. Could the cascade in the *Glashaus* not be an interpretation, in a more elegant form as Weale (1851) had proposed, of this feature?

However, it could also be proposed that all of the above arguments are still only circumstantial associations.

The *Victoria regia* glasshouse at the Berlin Botanical Gardens, Dahlem (Figure 80), has seven distinct portions to its outer half-circle plan; in contrast, the *Glashaus* had exactly twice this number and so formed a 'full' 14-sided plan. This straightforward analogy is made more tangible when the plan of the *Glashaus* is overlaid onto the Dahlem *Victoria regia* glasshouse (Figure 81). It now becomes evident that the proportions of both are strikingly similar, and both were apparently planned as a series of concentric circles. Of particular interest are the two semi-circular staircases that lead from the lower levels at the Berlin Botanical Gardens upwards to the *Victoria regia* glasshouse's upper terrace; this arrangement is distinctly similar to the interior staircases of the *Glashaus*. The positions of the columns supporting the *Glashaus'* dome align with the positioning of the riser strings of the *Victoria regia* glasshouse. Furthermore, the width of *Glashaus'* interior stairs aligns uncannily with the width of the Dahlem *Victoria regia* glasshouse's upper terrace. This alignment of proportion is again repeated when comparing the highest portion of the *Glashaus'* water cascade with the width of the central pool in the *Victoria regia* glasshouse. The Dahlem *Victoria regia* glasshouse had at its centre an elongated pool, which differs from the strictly circular pool that was common in the post-1860 examples of *Victoria regia* glasshouses. In a similar manner, the *Glashaus* also had an elongated 'pool' (cascade) at it centre.

To enter the Dahlem *Victoria regia* glasshouse, a visitor could proceed from either the lower gardens or the main palm house. This entailed either entering the darker, grotto-like lower floor (if entering from the lower gardens), or down a flight of stairs and then across a brightly lit double-volume space (if entering from the main palm house). Principally, these two routes then converged at a central point that proceeded upwards, originally through a set of curving stairs, to a Swampland glasshouse above with a glazed dome. Once again, this route was distinctly similar to that of the *Glashaus.* In Taut's design, the visitor proceeded up an initial flight of stairs contained in the flared circular base and then entered the building by climbing the semi-circular stairs that led ultimately to the brightly lit dome area above. From here, the visitor progressed downwards using a different set of semi-circular stairs into the darker Cascade Room. Following the cascade downward, the visitor was then directed into the shadowy, more constricted and linear kaleidoscope room, which eventually led to the exit. The original Swampland glasshouse of the Berlin Botanical Gardens has today been replaced by a flat-roofed concrete reception hall, and the spiral staircases have been replaced by a lift. The original Swampland glasshouse had at its centre an oculus, which illuminated the *Brunnensaal* (Fountain hall) below (Figure 82). The light from the oculus was directed downwards through a small colonnaded structure towards a small circular fountain at the centre of the *Brunnensaal*'s floor. This original arrangement is strikingly similar to the *Glashaus*.

Therefore, it can be argued that the 'inspiration' of the *Victoria regia* glasshouse is highly evident in a number of key features of the 'design' of the *Glashaus*. However, what is still required is the evidence that would establish the correlation of this *Victoria regia* 'inspiration' within Taut's writings. Direct evidence of this can be found in Taut's 1920 film script entitled, "Die Galoschen des Glucks", and in his 1920 publication *Die Auflösung der Städte.*

In "Die Galoschen des Glucks", Taut made a direct reference to the *Victoria regia*:

> ...the man leads the youth into a wondrous chamber. Here there are many strange growths, great floating leaves (like victoria regia) and many others. The man takes a curious rod, tickles the growths with its point, and out of the leaves grow houses, yes houses, as sparkling and dreamlike as his own, like opalescent domes, butterfly-wing buildings—oh, inexpressible—a fairy-tale city reflected in the water, ravishingly beautiful (Whyte & Taut, 1985 p.120).

Apart from the direct mention of *Victoria regia*, the above quote refers to houses that ‘grow’ from giant floating leaves—leaves that are like those of *Victoria regia*. Not just any houses ‘grow’ from these *Victoria regia*–like leaves, but domed opalescent shimmering houses. The “Die Galoschen des Glucks” has already been proposed as an analogy of Taut’s life up to 1920—the ‘youth’ is Taut, the ‘man’ is Scheerbart and the ‘wondrous chamber’ is possibly a *Victoria regia* glasshouse. From the extract above, “as his own” can be interpreted in two ways: it could either be the ‘houses’ of the ‘man’ (Scheerbart), or it could also refer to the ‘houses’ of the

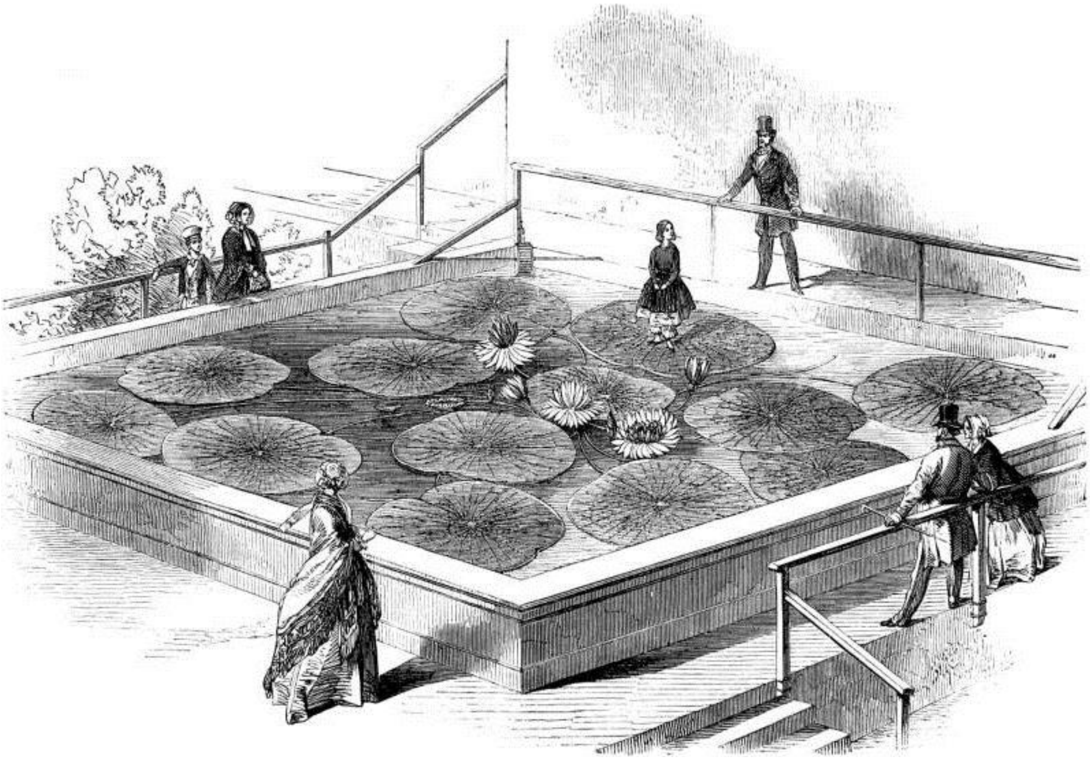


Figure 83 Joseph Paxton’s daughter Annie standing on a *Victoria regia* leaf (Image: www.commons.wikimedia.org).

‘youth’ (Taut). Thus, “as his own” could refer to Taut’s own sparkling dream-like house—a house that grows from ‘giant floating leaves’. Could the quote therefore be a retrospective acknowledgment by Taut that the *Victoria regia* served as the direct inspiration for his *Glashaus*?

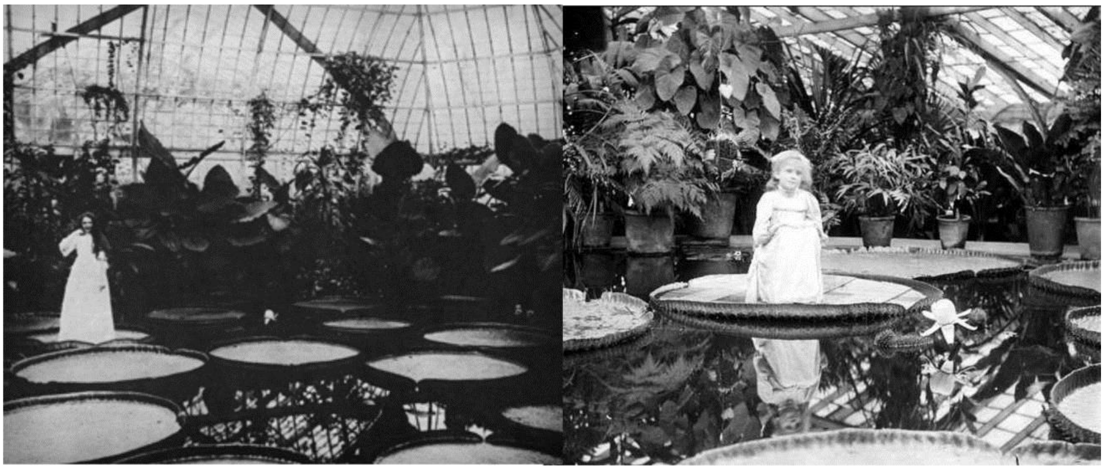


Figure 84 Left - Annie Means stands on the leaf of *Victoria regia* in 1895 at the Phipps Conservatory in Pittsburgh, Pennsylvania. Right - Young girl on the leaf of *Victoria regia* at the Adelaide Botanical Gardens in 1910 (Images: right - www.flickr.com/photos/state_library_south_australia/; left - www.phipps.conservatory.org).

In *Die Auflösung der Städte,* Taut illustrated what appears to be the 'houses' that grew from the 'giant floating leaves' (Figure 24), in an image of 1920 entitled *Die Grosse Blume.* A comparison between the *Die Grosse Blume* and the *Glashaus* reveals some similarities: the overall composition of *Die Grosse Blume* is concentrically planned like the *Glashaus*. The largest leaf had seven distinct portions like the *Glashaus*. Could this largest leaf be proposed as the flared concrete base that surrounded the *Glashaus*? On the largest leaf, a smaller leaf, with a ring of 'columns' to the periphery was also present. Could this smaller leaf be the main body of the *Glashaus* that included the circulation stairs with its ring of reinforced concrete columns? At the centre of this smaller second leaf was a further smallest leaf. This smallest leaf was in turn surrounded by a ring of more delicate 'columns'. Could this be representative of the *Glashaus'* inner dome with the Cascade Room below? Curiously, the *Die Grosse Blume* had a tower-like object that appeared at the periphery of the smaller leaf. While this could immediately be proposed as the dome of the *Glashaus*, it would be problematic because it is not placed at the centre of the leaves.

An alternative explanation for this tower-like object could be that the opalescent, sparkling tower-like structure in reality represented the kaleidoscope that was present in the *Glashaus*. This is probable considering that the tower-like object is illustrated as apparently emitting light. Alternatively, the tower-like structure could have a more direct connection to the story of the *Victoria regia*. On

17 November 1849, the *London News* published an image of Joseph Paxton's daughter Annie standing on a *Victoria regia* leaf (Figure 83). This initial image, demonstrating the phenomenal carrying capacity of *Victoria regia*'s leaves, served as the archetype for an act that was often repeated and photographed well into the 20th century (Figure 84). Seen in this light, could the tower-like structure on the 'leaf' be symbolic of this specific *Victoria regia* act?

"Die Galoschen des Glucks" continued:

> Glow worms suddenly appear and come nearer. Seen from above they are illuminated glass domes. One unfolds and turns into an architectural flower, with a moving light at its base. We seem to fly inside. At the bottom of the flower [is] the shoe library of the Child of Fortune. He is surrounded by box-like compartments... He opens the compartments and examines the shoes... On a glass table in the middle of the room stand the two pairs of lucky shoes... Satisfied, he takes them in his small hands and flies out of his blossom-house (Whyte & Taut, 1985 p.122).

Victoria regia (Figure 21) is most renowned for its massive leaves and gigantic flowers. Startling similarities are evident when a comparison is made between a *Victoria regia* flower and the quote above. *Victoria regia* is pollinated by scarab beetles that belong to the Genus *Cyclocephala*. These Scarab beetles fly into the flower of *Victoria regia* and are captured by the flower, only to be released after a 24-hour period. Are the 'glow worms' that become glass domes that then metamorphose into architectural flowers not the *Victoria regia*'s scarab beetles? The flowers of *Victoria regia* are initially a brilliant white, but slowly metamorphose into a pinkish colour over a 24-hour period. The flower of *Victoria regia* is divided into two distinct portions, namely an upper open portion mainly comprising the petals, and a lower enclosed space (Figure 30) that contains the reproductive organs.

The upper portion of the flower is comparable to the dome of the *Glashaus.* The geometry of the upper portion of *Victoria regia* flower looks remarkably like the geometry of the *Glashaus* dome. Additionally, the lower portion of the flower, separated by an oculus from the upper portion, has a strong affinity to the Cascade

Room of Taut's *Glashaus*, which was also separated from the Dome Room above it by an oculus. The lower portion of the *Victoria regia* flower contains the blooms' reproductive organs and appears as highly 'compartmentalised'. This is comparable to 'box-like compartments' of the 'shoe library' in the quote. Similarly, the 'table at the centre of the room' could be the oculus that was at the centre of the *Glashaus*. Finally, the 'moving light' at the base of the 'architectural flower' could well be the glass spheres that surrounded the base of the *Glashaus*. Therefore, Taut's reference to 'architectural flower' and 'blossom-house' makes a strong, though implicit connection between his *Glashaus* and the *Victoria regia*.

It is clear that the general 'inspiration' of botanical glasshouses was provoked by the specific 'inspiration' of the *Victoria regia*, which in turn can be linked with the central components of the 'design' of the *Glashaus*. 'Inspiration' and 'design' are then linked with the 'poetics' of Taut's writings. My argument establishes that it is highly likely that Bruno Taut directly referenced *Victoria regia* in his design of the *Glashaus*.

From the discussion of the *Victoria regia* and the *Glashaus* another important aspect becomes evident: the *Victoria regia* was not only a prototype to be copied, it was also a powerful symbol of prowess that reflected the desires of the client. On the one hand, the *Victoria regia* glasshouse of Ortgies (1850) embodied the distinct commercial aspects of the van Houtte nursery business. Borsig (1851), on the other hand, constructed his glasshouse for profit and advertising; his glasshouse was intended to be a technical prototype that would expose the public to glasshouses, fountains and irrigation equipment of the Borsig Works. Meanwhile, the *Victoria regia* glasshouses constructed at the Berlin Botanical Gardens were meant to be a central attraction, and to implicitly express the national prowess of the emergent German nation. Likewise, the Lyon (1888) glasshouse was intended as a progressive symbol of 'modernity'.

The quote from "Die Galoschen des Glucks" in which Taut (1920b) made a direct reference to the *Victoria regia* contains a reference to a 'man' that introduced him to the lily. As the client of the *Glashaus*, the *Deutsche Luxfer Prismen Syndikat* (German Luxfer Prism Syndicate) initiated, predominantly funded, and donated the majority of the building materials (including supplying many of the exhibits) of the *Glashaus* (Neumann, 1995a). It would therefore seem appropriate that, for the *Deutsche Luxfer Prismen Syndikat*, the *Glashaus* was intended as a symbol of the prowess of the company and their products. An often overlooked aspect concerning the *Deutsche Luxfer Prismen Syndikat* is that it was headed by charismatic German émigré to the United States of America, Frederick Louis Keppler. Paralleling Taut's increasingly marginalised role in the *Glashaus* design, Keppler too has received little consideration. Thus, it is Keppler's role that will be explored in the following chapter.

Chapter 4: The client - Frederick Keppler

4.1 Introduction

Considering that Luxfer Prisms provided the fundamental connection between Frederick Keppler, the *Deutsche Luxfer Prismen Syndikat* and the *Glashaus*, any discussion would be incomple without first providing an explanation of these.

Early in the 17th century, light-redirecting glass products began to be used to illuminate the darker areas of both ships and mines (Neumann, 1995a). With the advent of industrialisation and associated urbanisation, the need to light the darker areas of buildings, especially basements, arose. This task was initially achieved through the use of open grates, using a system that was generally termed as vault lighting. However, early applications of open vault lights proved unsatisfactory, as they admitted precipitation and were non-trafficable. The open frame of vault lighting was soon in-filled with glazing. Initially, the glass in-fill was housed in an iron or steel frame. Later, reinforced concrete was also increasingly used as a structural material. At first, the glass in-fill was a rough bull's-eye product, which simply allowed light to pass through. With the advance of technology, they evolved into more sophisticated prismatic-shaped devices, which directed the light to the required location (www.glassian.org). However, the majority of these vault lights were only suitable for horizontal, load-bearing applications.

With the introduction of the Chicago skyscraper in the late-19th century, the need to light deep plan spaces arose. Before the widespread availability of electric lighting, prismatic glass was an architectural product that was placed on the façade of a building to precisely redirect natural light to interior spaces through both refraction and reflection. Thus, a vast number of prism glass manufactures originated on the east coast of the United States of America, among them the American 3-Way Prism Company of Philadelphia; the Solar Prism Company of Cleveland; the Condie-Nealle Glass Company of St Louis; and the Jupiter Prism Company of Davenport, Indiana (www.glassian.org). The Luxfer Prism Company, established in 1897, was an amalgamation of the Radiating Light Company and the Semi-prism Glass Company. It was established to commercialise the prismatic glass tiles initially invented by the British inventor James G. Pennycuick in 1885 (Neumann, 1995a). These tiles were correctly referred to as Luxfer Prisms. However, today 'Luxfer tiles' is a common term for all forms of prismatic glass, regardless of manufacturer (www.glassian.org).

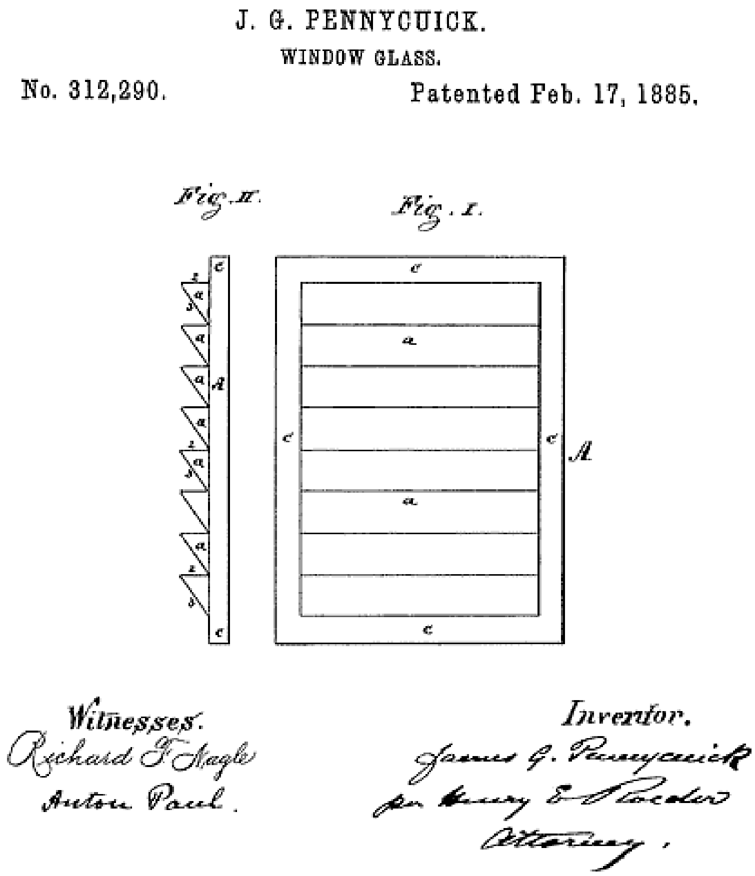


Figure 85 J. G. Pennycuick's 1885 patent for 'an improvement in window-glass' which later became Luxfer prismatic glass tiles (Pennycuick, 1885).

In 1881, Pennycuick and Peter Collamore were granted a patent for the improvement of vault lighting tiles through the use of semi-prism, or 'star shaped' vault lights, that would increase the amount of light for reflection (Pennycuick & Collamore, 1881). Following this initial patent, in 1885, Pennycuick was granted a further patent (Figure 85) for the improvement of window glass (Pennycuick, 1885). This 1885 patent proposed a vertical or inclined window system, composed of a number of glass tiles, which would dramatically increase the light reflected into a room without increasing the size of the window. The proposed tiles consisted of a small pane of glass that had a regular surface on one side, and of a series of parallel prismatic projections on the other side; thus, Luxfer Prisms were invented. To commercialise his 1885 patent, Pennycuick together with a group of Chicago entrepreneurs founded the Radiating Light Company in October 1896. Two months later, its name changed to the Semi-prism Glass Company, which later changed in March 1897 to the Luxfer Prism Company (Neumann, 1995a). The financial power of the Luxfer Prism Company's investors, combined with an astute marketing strategy, resulted in Luxfer Prisms being perceived as a grand concept rather than a simple product. Luxfer Prisms were clearly marketed to address the concerns of both the thriving and sophisticated Chicago environment and the wider west-coast American context. In its marketing material, Luxfer promised substantial savings to downtown businessmen and their architects. These savings were to be achieved through an increase in the available space and improved working conditions. Luxfer also claimed that its new and expensive prisms would contribute to the development of modern architecture. Fortuitously, the advent of Luxfer Prisms coincided with a period of both widespread passion for modern technologies and a growing awareness of a more simple life in agreement with nature. As such, Luxfer Prisms were marketed as both a product of scientific progress and as an antidote to modern civilisation and urbanisation. Luxfer Prisms negated the need for artificial lighting during the day by providing healthy natural light through scientific means. In turn, this negated the need for open windows and the subsequent exposure to the heat, noxious vapours, dirt and disease of the modern city (Neumann, 1995a).

As stated above, Luxfer Prisms were architectural products. As such, unlike traditional windows, which did little to enhance the architectural scheme of a building, Luxfer Prisms aided and created the architectural ornament of a building's façade: "When looked at from the outside they do not have the appearance of glass, for they lend themselves to the scheme of exterior treatment as to become a part of the whole surface" (Crew & Basquin, 1898 p.5).

To turn the marketing concept of progressive modernity into scientific reality, the Luxfer Prism Company hired the prominent physics and optics expert Professor Henry Crew and his assistant Olin H. Basquin of Chicago's North-western University. Luxfer's brief to Crew and Basquin was threefold: they were to further develop Luxfer Prisms; explore potential applications; and, most importantly, establish the scientific merits of the product. The basic principle of light reflection, through the use of prismatic glass, could not in itself be patented, as it was very common and by no means new. Crew and Basquin alternatively developed the scientific ability to predictably and precisely control light reflection through the use of Luxfer Prisms. Crew claimed that this notion was derived directly from August Fresnel's mathematically exact system of prismatic lenses that had been in common use in light-houses since the early 1820s. Through directly observing Chicago daylight conditions, Crew and Basquin subsequently developed precise mathematical formulas to exactly calculate the specific lighting requirements of buildings, predictably using Luxfer Prisms (Neumann, 1995a). These formulas were subsequently published by the Luxfer Prism Company in January 1898 and firmly established the scientific merit of Luxfer Prisms (Crew & Basquin, 1898). Additionally, by 1897, the Luxfer Prism Company had submitted 162 patents for production equipment, technical details, supporting frames and canopies for prism tiles. Of these, 96 were for particular design of Luxfer Prisms, and of these, 41 solely concerned so-called 'Iridian' prisms. Interestingly, it has been claimed that it was Crew and Basquin, and not Pennycuick, who invented prismatic glass, and supposedly exhibited their invention at the 1893 World's Colombian Exposition (Neumann, 1995a).

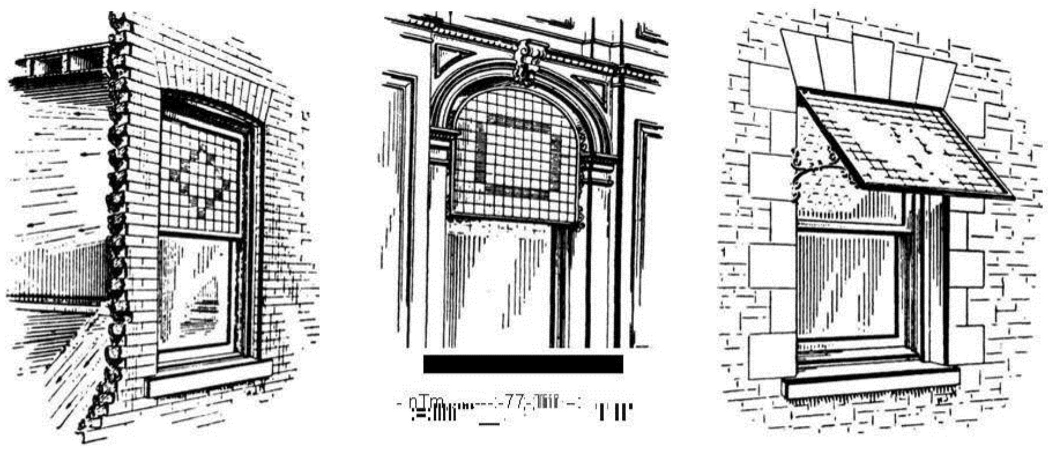


Figure 86 The Luxfer Prism Company's three methods of installation: On the left is the *Window Plate*; in the middle is the *Forilux*; while on the right a *Canopy* is illustrated (Neumann, 1995b).

Initially, patented Luxfer Prism glass tiles were 100 millimetres square and approximately 4.75 millimetres thick; larger sizes became available as manufacturing technology and techniques evolved. At first, Luxfer offered four grades, or types, of glass prisms ('Cut', 'Commercial', 'Factory', And 'Iridian') and nine degrees of refraction in accordance with different lighting conditions (Neumann, 1995a). Cut prism were the very best quality glass, individually tested by polariscope, and exactly polished and ground to within 1/100th of an inch. Furthermore, Cut prisms were only intended for assembly using the patented technology of electro-glazing or electro-deposition, a technology patented by William Winslow of Chicago in 1897 (Winslow, 1897). Significantly, electro-glazing was the most significant of the 162 patents filed before 1897. Interestingly, the original Winslow patent makes no assignment to the Luxfer Prism Company, despite the fact that Neumann listed Winslow as one of Luxfer's directors (Neumann, 1995a). The process of electro-glazing further made the supporting structure as light and as strong as possible, as well as making the finished pane of prisms both wind- and water-proof. Commercial prisms were considered as an inferior class of Cut, because they were not tested by polariscope or polished. However, they were ground, and thus suitable for electro-glazing. Factory prisms were rejects or 'second' prisms that were neither suitable for Cut nor Commercial grading. However, like Commercial prisms, they were also ground and appropriate for use in electro-glazing. Iridian prisms had the same features as Cut, but with the further application of an ornamental pattern to the regular surface of the prism tile, i.e. the side not occupied by the parallel prismatic projections. Iridian prisms appear to depart from the strictly scientific intentions of Cut, Commercial and Factory prisms in that they also embodied additional 'architectural qualities' since they interacted in a peculiar manner with the surrounding building façade (Crew & Basquin, 1898). Through the use of Iridian prisms "…a design may be inwrought upon the face of the prism plates in variety and beauty only limited by the capacity of the designer" (Crew & Basquin, 1898 p.5). The resultant harmonious effect created by Iridian prisms was described as extremely opulent, taking its colour from the surround materials and context. Iridian prisms therefore produced "…a fine textile-like effect…" with the "…appearance of the product is that of a highly interwoven crystal fabric, as delicate and brilliant as the most exquisite of cut glass ware" (Crew & Basquin, 1898 p.6). Furthermore, all of Luxfer's initial 41 Iridian prism designs were conceived by the young architect, Frank Lloyd Wright, who, on behalf of the Luxfer Prism Company, filed the majority of their Iridian patents during October 1897. At the time, Wright occupied an office in the Steinway Hall on Van Buren Street in Chicago. This initial commission created a subsequent relationship between Luxfer and Wright; in 1898, Wright occupied office number 1119 of the Rookery Building and moved to office number 1104 in 1899 (Twombly, 1987), while the Luxfer Prism Company occupied office 1129 from 1897 to 1901 in the same building (www.glassian.org).

Luxfer Prisms were traditionally assembled into regular metal frames that were usually 600 to 1200 millimetres high and as wide as the opening into which they were being inserted. The tiles were held together in the frame by a grid of thin metal bars that were either zinc soldered together, or by the later, more complicated and expensive, system of electro-glazing (Neumann, 1995a). Typically, the completed Luxfer Prisms frames were installed in one of three ways (Figure 86). The first, termed as a 'Window Plate', was to replace all or some of glazed portions of a typical window. The second, termed a 'Forilux', was to place an independent frame of Luxfer Prisms in front of the opening portions of a window. However, these two methods were not the sole factor in determing the "…character of the installation…" (Crew & Basquin, 1898 p.15-6). The character was additionally determined by the arrangement of individual prism and combinations of various avaliable designs. Luxfer proposed a combination of Major and Minor Prisms. Major Prisms were designed to distribute light to almost all the interior portions of a room. Conversely, Minor Prisms were intended to distribute light to the portions of the room that were closer to the Window Plate and Forilux. As such, different levels of brightness could be achieved, depending on where the viewer was postioned in the room. Viewed from the outside, Minor Prisms appeared several shades brighter than Major Prisms. The third method of installing Luxfer Prisms was termed as a 'Canopy'. This involved a Forilux that was fixed above a façade opening and then tilted outward. Canopies were intended for use in instances were the opening to be illuminated was located in dense, high-rise urban enviroments, such as Chicago. Apart from illumination, Canopies also had further incidental applications; it protected show windows, which thus dispensed with traditional awnings. To achieve "… very beautiful effects", Iridian prisms were further proposed for use in Window Plates, Foriluxs and Canopies. The result was that the "…receiving surface thus shows a rich, substantial texture, sparkeling both inside and outside with an irradiation of crystal lines and forms" (Crew & Basquin, 1898 p.17).

By 1898, the Luxfer Prism Company was extremely successful, having created nearly 1,500 installations in nearly 100 cities across the United States of America (Unknown author, 1898). Of these installations, the vast majority were in Chicago, with New York in second place and Philadelphia in third (Neumann, 2010). In an effort to increase their market share, the Luxfer Prism Company further established a number of foreign branches. On 11 May 1898, Luxfer established its first international subsidiary, the London-based British Luxfer Prism Syndicate, Limited (www.luxfercylinders.com). It was established by Basquin, who, in January 1897, became the director of Luxfer's Scientific Department, and, from 1898 to 1899, was the Chief Engineer of Luxfer Prism Companies of Europe (Robert. C McLean, 1898; www.glassian.org). In 1899, Basquin also established the German branch, namely the *Deutsche Luxfer Prismen Syndikat GmbH* (German Luxfer Prism Syndicate, Limited) (Neumann, 2010). Other European branches, also established in 1899, included the Paris, Lyon and Brussels-based *Société Luxfer* (Luxfer Society) and the Vienna-based *Luxfer Österreichische Glas und Eisenbau Geschäft, MBH* (Austrian Luxfer Glass and Iron Construction Company Limited). Furthermore, in 1906, the Budapest-based *Osztrák-Magyar Luxfer Prizma Gyár, KFT* (Austro-Hungarian Luxfer Prism Factory, Limited) was established (Neumann, 1995a). As a result of these foreign branches, in 1889, the Luxfer Prism Company distinguished the Chicago parent company by renaming it as the American Luxfer Prism Company (www.luxfercylinders.com).

The European branches of Luxfer, like their American parent, aggressively pursued the attention of both the public and the architectural profession. In January 1898, the Luxfer Prism Company announced a competition for "…competitive designs setting forth in a definite and comprehensive manner new possibilities in the use of Luxfer prisms as a building material" (R C McLean, 1889a p.63). The competition announcement by the *The Inland Architect and News Record* called for solutions that proposed how a product, supposedly as innovative as the elevator, could be both utilised and united with architectural effects. The total prize money offered by the Luxfer Prism Company was $5,000. First, second and third prizes in

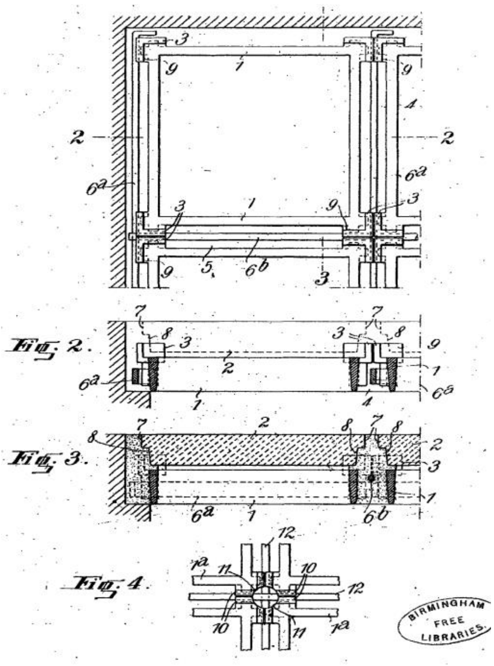


Figure 87 Left - Frederick Louis Keppler (Keppler, 1922).
Figure 88 Right – The 'Keppler System' (Keppler, 1910).

the Luxfer competition were awarded to Robert C. Spencer, Adamo Boari, and S.S. Beman respectively. The competition judges included the prominent Chicago architects Daniel H. Burnham, William Le Barron Jenny, William Holabird and Frank Lloyd Wright, and Prof. Henry Crew was also present (Robert. C McLean, 1898). Of note is the fact that while Wright occupied office number 1106 in Steinway Hall during 1899, Adamo Boari was next door in office 1107 with the firm Perkins and Spencer. As such, while each architect designed 'separately', a lively association developed, resulting with each participating in each other's work. Boari later also became a member of Wright's dinner club 'The Eighteen' (Twombly, 1987). Boari is most famous for his later 1904 design for the *Palacio de Bellas Artes* (Palace of Fine Art) in Mexico City.

4.2 Frederick Louis Keppler

In the late 1890s, the Luxfer Prism Company employed Frederick Louis Keppler (Figure 87). Keppler was born on 14 September 1862, in the small town of Schorndorf, just east of Stuttgart, Germany (Keppler, 1896). When Keppler migrated to the United States of America in 1878, he was an unskilled 16 year old (Leist, 1878). However, the *Obituary Records of Yale University* (Unknown author, 1921) listed Keppler as having trained at the *Stuttgart Polytechnikum* (Stuttgart Technical

Institute) before he migrated. Additionally, in Keppler's obituary published by the *New York Times* (Unknown author, 1940), Keppler was said to have attended both school and university in Germany. Furthermore, this same article also listed Keppler's father as having been a Court Architect to the Principality of Wuerttemberg. On his arrival in the United States of America, Keppler initially lived in Chicago and Milwaukee, and in 1883, was naturalised as an American citizen in Chicago. In 1896, Keppler's listed occupation was as a Chicago-based builder (Keppler, 1896). Additionally, in both 1895 and 1897, a 'Mr and Mrs Frederick Keppler' were listed as having resided at 5422 Ellis Avenue in Chicago (The Chicago Directory Company, 1894, 1896). Keppler subsequently departed the United States of America, bound for Europe, on 4 January 1898, and was eventually a resident in Berlin from March 1899. Keppler appeared to live in Europe from this point forward. During 1899, his occupation was listed as that of an architect (Keppler, 1899b). In 1904, while still in Berlin, Keppler listed his occupation as being associated with the Luxfer Prism Company/Syndicate (Keppler, 1904). An article in the *New York Times* (Unknown author, 1940) stated that, in the late 1890s, Keppler was sent to Germany as a representative of the Luxfer Prism Company.

Exactly how Keppler initially became to be associated with the Luxfer Prism Company is still unclear. In December 1887, a 'Fred Keppler' was mentioned as having been a member of the Chicago Architectural Sketch Club and who was present at its second annual banquet (R C McLean, 1887). Later, in 1889, Keppler's marriage to Elizabeth Neely was announced, and the article further described him as a prominent member of the Chicago Architectural Sketch Club (R C McLean, 1889b). Keppler's business acumen first became obvious in 1891 when he was described as an architect of considerable local prominence and esteem and who had abandoned the architectural profession in favour of starting the Mackolite Plaster Board Company. Keppler was apparently responsible for introducing Mackolite to the United States of America from Germany (R C McLean, 1891). Mackolite, invented in Ludwigsburg, Germany, by Messrs. A & O Mack, was ground gypsum that was then mixed with other chemicals and water and moulded into the required shape (Unknown author, 1906). In 1888, the Mackolite Fireproofing Company was the first industry to be established in Chicago Heights (Candeloro &

Paul, 2004). On 4 June 1891, Makolite's fire resistance was exhibited in Chicago at the end of Ohio Street; an event deemed of such significance that it was recorded in detail. In these tests, two small structures, one with steel and the other with timber frames, clad in Mackolite and topped with plaster, were set alight. The results indicated that Mackolite would contain a fire within any particular room (R C McLean, 1891). Interestingly, in 1899, after a Chicago building equipped with Luxfer Prisms survived a fire, Luxfer added fire-proof glazing to its product line (www.luxfercylinders.com). As such, in 1900, the Board of Underwriters accepted metallic Luxfer Prism glazing as being fire-proof (R C McLean, 1900).

As the discussion above indicates, it is highly probable that Keppler joined the Luxfer Prism Company based on his architectural background, business acumen and fireproofing experience. It is also highly probable that Keppler headed the *Deutsche Luxfer Prismen Syndikat* from its very beginning, or very shortly after, in 1899. On 31 December 1899, Basquin departed Hamburg, Germany, bound for New York. He was accompanied by his family; namely, Jersy Basquin, aged 22 and supposedly his wife, together with their son Harold Basquin, aged 6 months (Hamburg-Amerika Linie, 1899). Could the birth of Harold have necessitated the return of the Basquins to the United States of America? If indeed this is correct, then this event would have left the *Deutsche Luxfer Prismen Syndikat* without a Director. Therefore, it is highly likely that in late 1899, Frederick Keppler became the Director of the *Deutsche Luxfer Prismen Syndikat.* With Keppler as its director, it soon became one of the most successful of Luxfer's foreign branches. He quickly acknowledged that patented Luxfer Prisms, their methods of construction, and their architectural applications had little practical application value in the European context (Neumann, 1995a). Keppler therefore patented a number of innovations, the most notable being a system of structural glazing called *Glaseisenbeton* (Reinforced Concrete and Glass), commonly known as the 'Keppler System' (Figure 88). The 'Keppler System' was initially patented in 1909 and further refined in 1913 (Keppler, 1909, 1910, 1913). At its core, the 'Keppler System' departed from the traditional method of assembling patented Luxfer Prism tiles in two main respects. First, Keppler used reinforced concrete instead of solder or electro-deposition to secure the glass tiles. Second, this use of reinforced concrete resulted in a thicker,

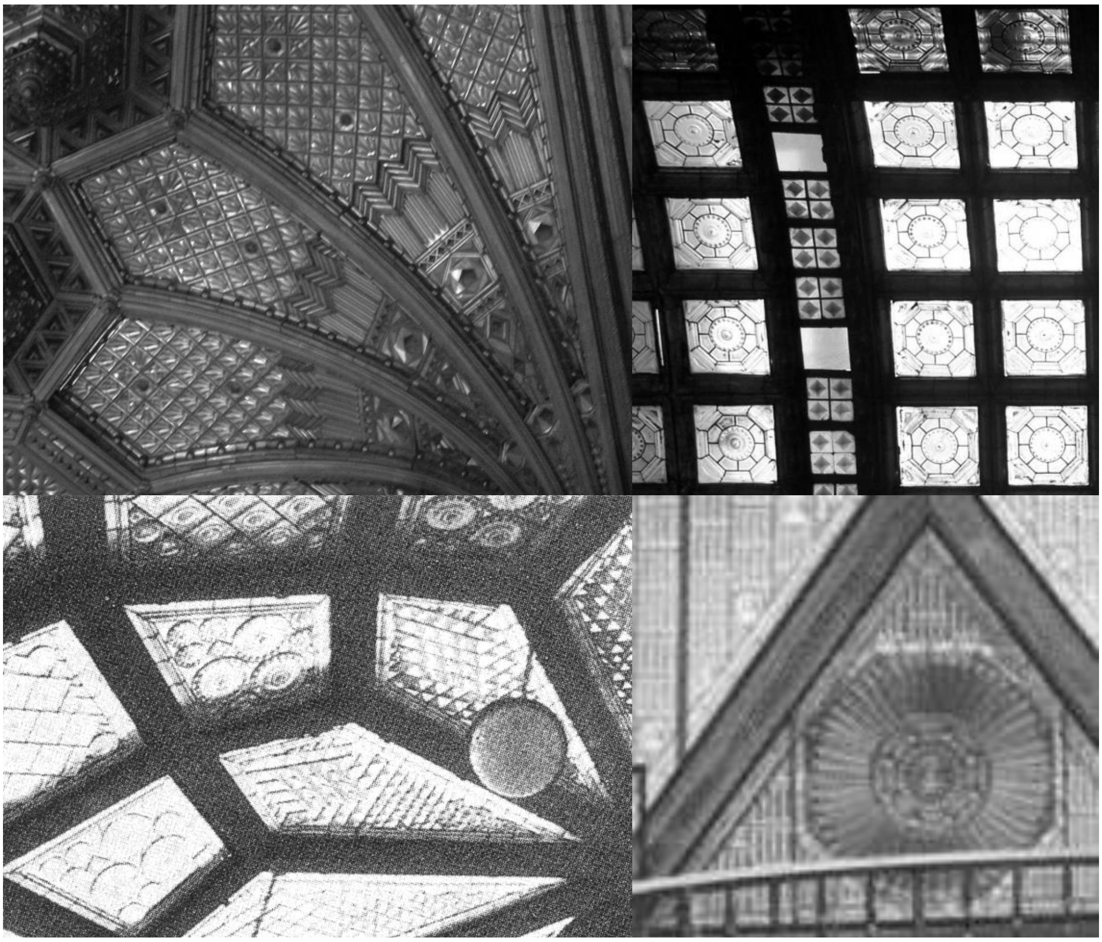


Figure 89 Top – The ‘prism tiles’ to the *Párisi Udvar* in the *Brudern Ház,* Budapest. Bottom – Frederich Keppler’s simplified’ glass tiles as used in the *Glashaus* (Images: Lower left - Thiekotter, 1993; Lower right - www.bildindex.de; Upper - www.glassian.org).

heavier glass tile. The resultant ‘simplified’ glass tiles lacked the precise prismatic ridges of patented Luxfer Prism tiles; had exposed edge ridges that secure the tile into the reinforced concrete; and were also less transparent than patented Luxfer Prism tiles (Neumann, 1995a).

4.3 Exhibiting Luxfer products

Since the late-19th century, American and European glass manufacturers had exhibited their products at trade fairs and public exhibitions. According to Neumann (1995a), the ‘glass pavilions’ built for these exhibitions, formed a unique building style that owed much of its effect to the particular details of the products used. Even Taut (1914c) wrote that the *Glashaus* mostly owed much of its magical effect to the products of the *Deutsche Luxfer Prismen Syndikat.* Many of these ‘glass pavilions’ followed an established programme of glazed domes, staircases, and even the inclusion of a central fountain. According to Neumann (1995a), Luxfer’s

European branches also frequently participated in trade fairs and exhibitions and actively sought the attention of architects. Furthermore, Neumann (1995a) stated that Luxfer presented its products in a separate exhibition pavilion at the Brussels International World Fair in 1910. The periodical *Diamant* (1910) made mention of the *Deutsche Luxfer Prismen Syndikat* as having delivered magnificent domes of prism glass for several exhibition pavilions at the Brussels International World Fair. These domes, according to *Diamant* (1910), offered amazing lighting effects. In 1913, the *Deutsche Luxfer Prismen Syndikat* participated in the *Baufachausstellung* (Building Trade Exhibition) in Leipzig, where it won a gold medal for a Bruno Möhring–designed domed pavilion that used "...prismatic glass, glass tiles and reinforced concrete" (Neumann, 1995a p.44). According to *Diamant* (1913), this Leipzig pavilion was located close to the six-sided pavilion of the *Vereins Deutscher Spiegelglasfabriken* (Association of German Plate Glass Factories). This *Kuppelbau* (Domed building) was further described as having had a reinforced concrete structure that was in-filled with 'art glass'. The dome was described by *Diamant* (1913) as having been exceptionally beautiful, made from *Elektroglasprismen* (Electro-deposition fixed glass prisms) and that were contained in a dainty copper frame.

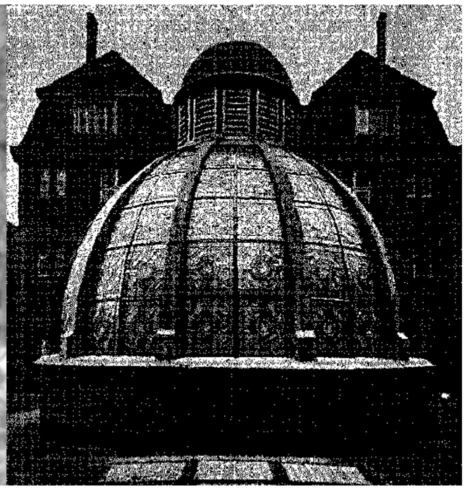


Figure 90 Left – The vault lighting to the *Brudern Ház*; supplied by the *Magyar Luxfer Prizma Gyár, KFT* (Image: www.glassian.org).
Figure 91 Right – The reinforced concrete, Luxfer dome over the *Krüger-Passage*, Dortmund (Image: Liese, 1923).

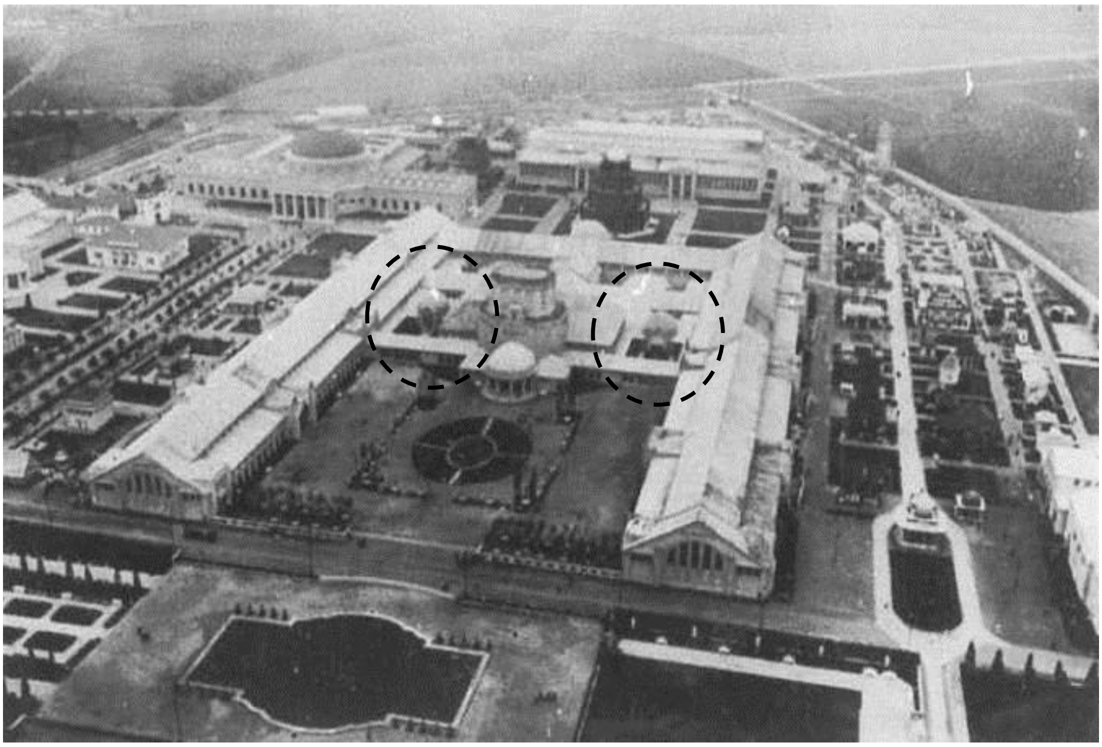


Figure 92 The 1913 Leipzig *Baufachausstellung.* The large ‘U’ shaped building in the foreground comprises a number of long shed like buildings: *Baukunst (Building art)* is on the left, *Raumkunst (Interior art)* at the rear centre, *while Baustoffe (Building materials)* is on the right. Directly to the rear of the ‘U’ shaped building is Bruno Taut’s *Monument des Eisens*. Located in the middle of this ‘U’ shaped building is what appears to be the Pavilion for *Vereins Deutscher Spiegelglasfabriken.* Considering the *Deutsche Luxfer PrismenSyndikat****’s*** pavilion was apparently in close proximity to that of the *Spiegelglasfabriken,* then one of the circled *Kuppelbau* could be the *Deutsche Luxfer PrismenSyndikat****’s*** pavilion (Image: www.bildindex.de).

While not being examples of exhibition architecture, two further interesting examples of Luxfer installations were the *Brudern Ház* (Brudern House) with its *Párisi Udvar* (Parisian Court) in Budapest, Hungary, and the *Krüger-Passage* in Dortmund, Germany. The *Brudern Ház* was designed by Henrik Schmahl and constructed in 1909 (Heathcote & Collie, 1997). This example is interesting, not because it was like many of the commercial installations to which Luxfer’s European branches supplied products, but because the ceiling in its *Párisi Udvar* appears to use prism tiles that are almost identical to Keppler’s simplified glass tiles used in the *Glashaus* (Figure 89). While it is not clear who exactly supplied them, it is however interesting to note that Luxfer’s Hungarian branch, the *Osztrák-Magyar Luxfer Prizma Gyár, KFT*, supplied the vault lighting (Figure 90). Of further interest is that the *Brudern Ház*’s floor tiling, albeit mostly ceramic, was likewise similar in appearance and layout to that of the *Glashaus*. The next interesting example is the Luxfer dome over the *Krüger-Passage*, designed by the architects Hugo Steinbach and Paul Lutter. This dome is of importance because it, like the *Glashaus*, also had a reinforced concrete structure (Figure 91).

Also exhibiting at the 1913 Leipzig Exhibition were the *Deutscher Stahlwerks-Verband* (Association of German Steel Workers) and the *Verband Deutscher Brücken-und Eisenbaufabriken* (Association of German Bridge and Steel Fabricators). These two associations chose Bruno Taut to design their pavilion, the *Monument des Eisens* (Gutschow, 2006). In the *Monument des Eisens,* Taut, much like the architects to the glass manufactures, "...used the very material he was hired to advertise and promote in order to create an abstract, geometric, exposed steel-frame construction" (Gutschow, 2006 p.65). Neumann (1995a) stated that images of the *Deutsche Luxfer Prismen Syndikat's* 1913 Leipzig pavilion are yet to be found. However, if Figure 92 is studied in conjunction with the descriptions of the pavilion above, it is probable that one of the circled buildings could well be Luxfer's 1913 pavilion. If this is the case, then it is clear that this existing prototype that was supposedly enforced by the *Deutsche Luxfer Prismen Syndikat* could have both dictated and limited Taut's design choices for the 1914 *Glashaus.* This contention is supported by the fact that while the *Glashaus* had a reinforced concrete structure, Taut initially proposed an iron skeleton for the dome and columns (Thiekotter, 1993). Taut's intended use of structural steel in all probability derived from his experiences with the material in both his *Monument des Eisens*, and his earlier 1910 pavilion for the structural steel manufacturer *Träger Verkafs-Kontor* at the 2nd Ceramic, Cement and Lime Industrial Exhibit in Berlin. Apart from the construction of the *Monument des Eisens*, the Leipzig exhibition could also have been significant for Taut because it could have afforded him an opportunity to make contact with the *Deutsche Luxfer Prismen Syndikat.* Another explanation for the Taut*/Deutsche Luxfer Prismen Syndikat* relationship could be that Luxfer's Berlin offices were located at 204 *Friedrichstraße,* while the offices of Taut & Hoffmann were located a short distance away at 20 *Linkstraße* (Junghanns, 1983; Keppler, 1913).

From the above descriptions of glass pavilions, especially those of the *Deutsche Luxfer Prismen Syndikat,* there was a tendency to focus on the areas of these buildings where glazed products were most visible, particular the dome. Other aspects that were frequently mentioned include the geometry and the construction materials, method and technologies. Thus, considering that the products and construction technologies of *the Deutsche Luxfer Prismen Syndikat* were most evident in the upper two-thirds of the *Glashaus*, i.e. the dome and its lower supporting base that contained both the stairs at the periphery and the fountain at its core, these areas will be investigated further.

4.4 The *Deutsche Luxfer Prismen Syndikat* and the *Glashaus*

In keeping with the company's desire to associate with progressive architects, the *Deutsche Luxfer Prismen Syndikat* chose Bruno Taut to design their *Glashaus* pavilion at the Cologne *Werkbund* Exhibition of 1914*. The Deutsche Luxfer Prismen Syndikat* both initiated, majorly funded, donated the building materials, and supplied many of the exhibits to, the *Glashaus* (Neumann, 1995a). Nevertheless, Taut, acting much like a modern developer, also sourced other financial contributions and products, and his firm Taut & Hoffmann ultimately contributed 20,000 Marks to the cost of the *Glashaus* (Thiekotter, 1993). In the drawing that Taut and Hoffmann submitted to the Cologne City Council for building approval, the voids between the rhombic structure of the *Glashaus'* dome were drawn as double glazed, with the outer skin labelled as *Spiegelglas* (Plate glass) and the inner layer was labelled as *Luxferprismen* (Luxfer Prisms) (Taut, 1914b). The floor to the Dome Room was labelled as *Boden Luxferprismen mit Betonrippen* (Floor of Luxfer Prisms with concrete beams), while the stairs to the Dome Room were labelled as *Treppe Glassteine auf Eisenkonstru* (Glass-block stairs with steel construction). Furthermore, the glazed, non-structural in-fill that partly surrounded the staircases was simply referred to as *Glassteine* (Glass-blocks), while the flared circular ceiling below the oculus appears to be labelled as *'Uelmfang' Glas.* However, this is in all probability *Umfang Glas* (circumference glass). This contention is partly supported by Taut (1914c) when he stated that the ceiling below the oculus consisted of *Über-fangglas* (conical glass).

It is a common misconception that patented Luxfer Prisms were used in the *Glashaus'* dome. In reality, 'simplified' glass tiles filled the voids between the reinforced concrete structure in the *Glashaus'* dome (Neumann, 1995a). When Figures 14, 18 and 89 are referenced, one can see that these simplified tiles departed from the traditional 100 millimetre-square configuration of patented Luxfer Prism tiles. Supposedly in keeping with the *Deutsche Luxfer Prismen Syndikat*'s desire to diversify its product range, these simplified tiles constituted a variety of square, rectangular, circular and polygonal shapes, and appear to have had a simple pressed-surface design. Furthermore, the simplified glass tiles to the *Glashaus'* dome were held together by copper frames and strips, not according the newer 'Keppler System', but using Winslow's electro-deposition process (Neumann, 1995a). This fact is further supported by Taut (1914c). This use of Winslow's electro-deposition process resulted in much lighter triangular-shaped glazed in-fill panels, when compared to the heavier, but newer 'Keppler System'.

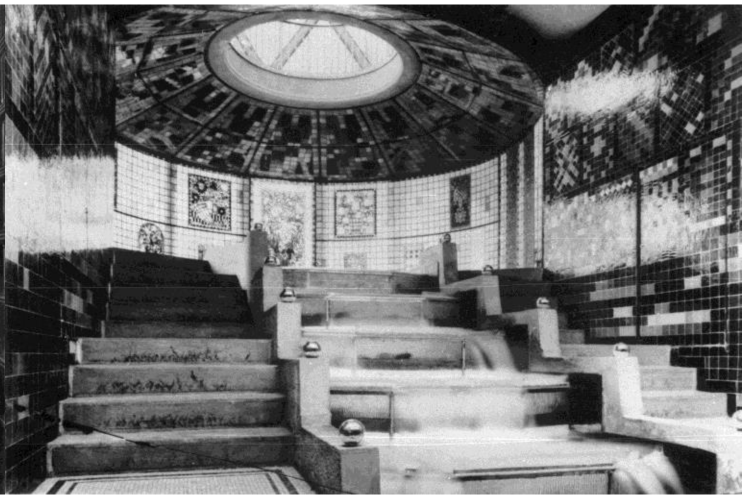


Figure 93 Left - The glazed non-structural 'Keppler System' walls that partially surrounded the *Glashaus*' staircases (Image: www.bildindex.de).
Figure 94 Right - The flared circular ceiling above the *Glashaus'* Cascade Room (Image: www.bildindex.de).

Thiekotter (1993) stated that, at some point, the depth of the structural members to the *Glashaus'* dome decreases from an initial 20cm to 12cm. This fact could be indicative of the heavier 'Keppler System' being the initial specification, but later being superseded by electro-deposition. However, Taut (1914c) stated that this reduction in structural size was due to structural optimisation by the reinforced concrete contractor, the *Allegemeinen Beton-und Eisengesellschaft* (General Reinforced Concrete Company) of Berlin. In addition to the in-fill panels of simplified glass tiles, the *Glashaus* also had a second outer layer of simple plate glass; effectively 'double glazing' the *Glashaus'* dome (Taut, 1914c). It has also been proposed that the Glashaus' dome constituted not of two layers of glazing but of three (Thiekotter, 1993). In one particular photograph of the *Glashaus*, there appears to be a 'third' coloured layer, possibly of glass or paint, to the interior of the dome (Figure 14). However, in other photographs, this layer is not visible. This discrepancy could be due to numerous factors. For example, in his later 1913 patent, Keppler stated that the colouring of hollow bricks of blown glass was achieved through either the use of metal deposition or paint (Keppler, 1913). Furthermore, the total unfinished state of the *Werkbund* Exhibition was universally deplored (Thiekotter, 1993). Even five weeks after its opening on 16 May 1914, the *Glashaus* was still not fully operational (Thiekotter, 1993). Additionally, the *Glashaus*' dome was expressly mentioned as multi-coloured, starting at its base in deep blue, then progressing upwards through moss-green, golden yellow and eventually culminating at the apex in brilliant creamy white (Taut, 1919a). When all of the above facts are considered, it becomes highly probable that the glazed panels installed in the *Glashaus'* dome were initially clear, with colour only being added later. Once the panels were installed, the most cost- and time-effective way to add colour would have been through painting. As such, the 'third layer of glazing' is in all probability a coating of coloured transparent paint, applied after installation was complete. Keppler (1914), writing in Keppler Glass Constructions, provided surprising insight into this argument. Under a section entitled 'Keppler Crystal Ceilings', Keppler described façade elements that were constructed from a choice of 150 transparent glass units that were relief ornamented. These units were held together in panels by copper electro-glazing, applied at a factory and installed into either the reinforced concrete or steel from-work of the proposed building. Through the use of 'Keppler Crystal Ceilings', a soft and evenly diffused light would be provided that reduced the need for artificial lighting. However, if artificial lighting was provided, then the 'Crystal Ceiling' would increase in its 'value' because of the fine interior reflective surface. Apart from being fire-resistant, the glass units or tiles were only available in either clear or golden amber (Keppler, 1914). It is thus more than likely that the variety of colours to the *Glashaus*' dome could only have come from the application of a third interior skin. Furthermore, given the above arguments and the common confusion around the actual naming of Luxfer's products, it is further evident that even the application of the term *Luxferprismen* might have been incorrect; rather, it should have been named as a 'Keppler Crystal Ceiling'. Additionally, it would have been highly unlikely for the *Glashaus*' dome to have been double-glazed; rather it was triple-glazed.

According to Neumann (1995a), the glazed, non-structural in-fill (Figure 93) that partly surrounded the staircases was pure 'Keppler System'. The staircases proper, leading from the entrance to the Dome Room and then downward toward the Cascade Room, were constructed using a steel frame that was in-filled with 'prismatic tiles' (Neumann, 1995a). However, when the staircases are examined in detail, these 'prismatic tiles' are not the same as those used in the dome, and are fixed according to the 'Keppler System', as evidenced by the presence of thick mortar joints.

The reinforced concrete structure to the floor of the Dome Room comprised 14 beams, which radiated outwards from a small inner ring-beam towards a larger outer ring-beam that was supported by 14 columns. The 14 radiating beams were laterally braced midway by a further third ring-beam. In-filling the gaps between the floor's structural members were circular glass tiles, possibly secured according to the 'Keppler System'. In the drawing submitted to the Cologne City Authorities, this floor was labelled as having comprised *Glassteine und Eisenbeton* (Glass-blocks and reinforced concrete) (Taut, 1914b). The word '*Glassteine*' was also used to describe the walls that surrounded the staircases. According to Neumann, the floor to the *Glashaus*' dome "...was made of concrete with coloured glass lenses embedded in it" (Neumann, 1995a p.43). Taut (1914c) stated that the floor consisted of yellow- and white-coloured Luxfer Prisms that were round and arranged in a rhombic pattern. However, what is unclear is whether the 'lenses' that both Neumann (1995a) and Taut (1914c) referenced allowed the transmission of light to the Cascade Room below. If the floor was a 'Keppler System', then it would seem logical to assume that it did. However, considering the extent of the concrete between the glass tiles, and the load-bearing nature of the surface, if the floor did allow the passage of light, then it could also have been another of the *Deutsche Luxfer Prismen Syndikat's* products – Keppler Floor, Roof and Vault Lighting.

The reality of the construction of the floor below the dome is partly revealed when the ceiling to the Cascade Room below is considered. In the Cascade Room directly below the oculus, Taut constructed a flared circular ceiling (Figure 94). At first glance, the construction of the panels that constituted this ceiling appear to be similar to the dome above in that it is apparently composed of a regular series of framed panels that contained 'glazed' tiles. However, on closer examination, these ceiling panels appear to be similar to the glazed ceramic tiles, or *Glas kacheln*, on the walls of the Cascade Room. The ceiling panels appear to have a thin metal frame to the periphery, which was then immediately lined by one row of square tiles. The rest of the panel was then in in-filled in a regular pattern, also using the same square tiles. However, unlike the panels to the dome above, these ceiling tiles appear to be highly reflective, possibly non-light-transmitting, and strongly coloured, indicating that they could be ceramic glazed tiles rather than 'simplified' glass tiles. Furthermore, if the ceiling panels were constructed using 'simplified' glass tiles, then it would be logical to assume that they would also have been coloured in a similar manner to those in the dome above. While the photographic evidence does not support the use of 'simplified' glass tiles, it does support the notion that the *Glashaus* had a reinforced concrete floor structure that was in-filled with circular glass tiles. These 'glass tiles' and the supporting structure were clearly evident on the upper surface of the Dome Room's floor, but they were not at all evident on the ceiling of the Cascade Room. This can be explained when considering Taut's (1914c) comments that the ceiling consisted of small, bright-red shimmering glass tiles backed with gold leaf, a material commonly known in German as *Goldsmalten* (small, gold-backed glass tiles). Furthermore, the *Goldsmalten* were supported by a leaded frame. Both the ceiling and wall coverings were designed by the Berlin company *J. Schmidt and Gottfried Heinersdorf* (Taut, 1914c).

If all of the above is considered, then it is highly probable that the ceiling was neither constructed with 'simplified' glass tiles or ceramic tiles; rather, it was composed of panels of *Goldsmalten*, which totally restricted or minimised the transmission of light. If the arguments presented in Chapter 2 are considered, then this curiosity becomes less so, in that the 'character' of each of the *Glashaus*' two principal spaces were distinctly different and divergent. The upper Dome Room was intended as a brightly lit, structurally expressive and lively space, while the lower Cascade Room was the opposite in that it was dark, sombre and controlled.

Essentially, the Cascade Room was cave-like, while the Dome Room was the opposite.

A further noteworthy element in the *Glashaus* was the cascade. At its highest level, this cascade consisted of a circular pond in the middle of the upper room, directly below the oculus. From the centre of this upper pond, a fountain gushed, with the water then flowing downward over five terraced steps and into a lower basin. The cascade was composed of both mirrored and ornamental glasses that were supported on sheets of plate glass, which were illuminated from the rear and below with Osram branded electric lights. Additionally, the rim of the cascade was lined with black glass tiles, and the floors of the cascade and basins were covered with glazed shards of waste left over from the glass-manufacturing process. The cascade was constructed by the Munich-based company *Zwieseler und Pirnaer*, which specialised in coloured-glass products; this company also supplied the tiles for, and constructed, the wall cladding to the Cascade Room. Once the visitor had descended the blue-and-black-mosaic-clad stairs on either side of the cascade, they would have viewed a steadily paced kaleidoscopic projection, which was composed of artistic creations. The effect of the projection was apparently to remind the visitor of their earliest childhood memories (Taut, 1914c).

In his description of the *Glashaus*, Taut (1914c) further elaborated on the effects of the lighting in the Dome Room. While the effect created was described as a precious and beautiful, highly faceted crystalline diamond, it was amplified through the use of electrical illumination. Seven glass spheres hung from the underside of the dome and each supplied a highly reflective, electric intensity of approximately 1,000-candle power each. The light from these seven spheres covered the entire interior of the dome, glittering as it reflected from the prism tiles. At the centre of these seven lights, a large grape-like light hung that contained numerous coloured and white electric light bulbs. All of the electric lighting to the *Glashaus* and the kaleidoscope were fitted with Osram products supplied by the Auer Company (Taut, 1914c).

From the above argument, certain accepted understandings regarding the *Glashaus* become doubtful. First, it seems that patented glass Luxfer Prism tiles were not used in the *Glashaus.* While both the drawing submitted to the Cologne

City Council (Taut, 1914b) and Taut (1914c) referred to *Luxferprismen* as having been applied to both the floor and cladding of the *Glashaus'* dome, in reality, simple pressed-glass tiles of varying shapes were used. The second concerns the origins of ‘simplified’ glass tiles and the resultant effect that they created. From the argument above, it is highly likely that Keppler’s ‘simplified’ glass tiles were merely a further iteration of the earlier Iridian product of the Luxfer Prism Company. Likewise, the crystalline, sparkling effect of the *Glashaus* dome, rather than being a unique creation of Expressionist architecture, was actually an additional evolution of Crew and Basquin’s marketing philosophy. The third, unclear, fact is more important as it concerns the general layout and aesthetics of the *Glashaus*. When the planning of the *Glashaus* is compared to that of the earlier ‘glass pavilions’, many similarities are evident, such as the use of a glass dome, staircases and a central fountain. Furthermore, the *Glashaus* also owed a significant portion of its sparkling, delicate and jewel-like effect to the particular products used in its construction. It was also similar *to Möhring’s* 1913 pavilion, which also used glass tiles and reinforced concrete. Interestingly, this planning arrangement and desire to exhibit the client’s materials in the best possible manner also has a connection to the 1913 *Monument des Eisens* because both had similar plans, and both expressed an aesthetic that best portrayed the products of the client. From this, it is clear that the *Glashaus* followed an established prototype, and was not a novel creation of Taut’s imagination. It is therefore proposed that examples of these prototypes will be found within the personalities that shaped the Luxfer Prism Company and prior exemplars of exhibition buildings, to which I now turn.

4.5 Exhibition buildings: In search of glazed domes, central features, staircases and structural expression

It has already been proposed, and as one would logically expect, that Taut’s *Glashaus* belonged to an existing tradition of exhibition buildings, where the needs of the client and associated products produced distinct building typologies. These exhibition or industrial pavilions were temporary objects that expressed the possibilities of their new and novel materials in an astatically pleasing manner.

In Germany, the exhibition pavilions that industries initially created were simply copies of existing landmarks, and were executed in modern materials that expressed their technical possibilities. It was not until the first decade of the 20th century that the material manufacturers started to demonstrate new formal and aesthetic characteristics of both their materials and their associated technical possibilities. However, these early examples were still largely based on historic typologies, like garden pavilions, mausoleums, and the likes. Additionally, with the emergence of large-scale industrial cartels, enterprises and brand profiles, there was a desire to reinvent sacred central planned buildings (Cire, 1993). Ciré (1993) further proposed that this situation prevailed until the emergence of highly original exhibition pavilions, like Taut's 1910 pavilion for the *Träger-Verkaufs-Kontor Firma*, where the exhibited material of red and black painted steel profiles became the primary display, while the historical typology, in the form of the small central tempietto, became secondary (Cire, 1993).

However, while the exemplars that Ciré (1993) exposed alluded to the *Glashaus*, none fully explained it. Arguably, a more appropriate exemplar for the *Glashaus* had already been previously exposed through horticultural glasshouses and the *Victoria regia*. However, even this reasoning needs further research to explain how an established prototype evolved and later came to be enforced as the prototype for Luxfer's European exhibition pavilions.

International exhibitions for the display of industrial products had their origins in post-revolutionary France. In 1789, the *L'Exposition publique des produits de l'industrie française* (Public Exposition of French Industrial Products) was held in Paris. On the *Champ de Mars*, a 'Temple of Industry', surrounded by 60 porticos, was erected and filled with a collection of French-produced industrial objects. At this Exposition, a system of awards for excellence in design and workmanship, which were decided by juries of distinguished gentlemen, was initiated. Following the success of this initial exposition, a further exposition was again held in Paris, this time on a much larger scale. This 1801 Exposition was held in a temporary building that was located in the quadrangle of the Louvre. Of the 200 exhibitors, mostly from the cotton- and wool-manufacturing industries, the most notable was Joseph Jacquard and his now famous mechanical textile loom. The success of this exhibition led to the establishment of the *Société d'encouragement pour l'industrie nationale* (Society for the Encouragement of National Industry), thus creating a powerful aid for French industrial sector. In 1802, 1806, 1819, 1823 and 1827, subsequent Parisian expositions were held that evolved in both size and success. At the 10th Industrial Exposition in 1844, 3,960 manufactures exhibited their products in a wooden building designed by Moreau and erected in the *Carre Marigny* on the *Champs Elysées* (Strahan, 1876). Initially, other nations, most notably The Kingdom of Sardinia, quickly acknowledged the French exposition model in promoting industrial development. In 1829, 1832, 1838, 1844, 1850 and 1858, Turin hosted a series of *Esposizione pubblica dei prodotti dell'industria* (Public Exhibition of Industrial Products) (Citta do Torino, 2006). Likewise, Spain, Portugal, Austria, Great Britain, Russia, Sweden, Denmark and the Kingdom of Bavaria also hosted industrial exhibitions, with those from Belgium being noted as the most numerous and important. Nevertheless, each of these exhibitions was strictly nationally based and it was not until 1849 that the possibility of international exhibitions was first discussed in France (Strahan, 1876).

4.6 London's Great Exhibition of the Works of Industry of all Nations, 1851

World Expositions, which started with the 1851 Exposition in London and continued until the 1938 Exposition in Paris (Tjaco, 2004), were explained as having been formulated within an 'era of industrialisation'. The London World's Exposition of 1851, officially named 'The Great Exhibition of the Works of Industry of All Nations', was undoubtedly most famous for Joseph Paxton's Crystal Palace, which, as the canvas, created a scene of industry for 14,000 exhibitors from 94 states, colonies and dependant territories, and attracted over six million visitors. Considering the large number of exhibitors, the organising committee developed a classification system of four sections and 30 classes. The Crystal Palace was subdivided into 1,500 exhibition units and allocated according to countries. Essentially, the plan of the Crystal Palace was based on the traditional religious archetype of the Latin cross. While the main axis of the building was entirely reserved for large sculptures, the cross of the plan was allocated for large palm trees and exotic vegetation. These provided cool and shade for the food and

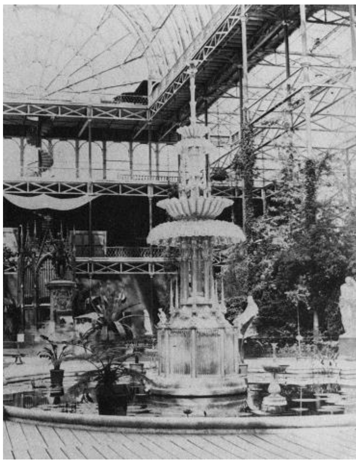
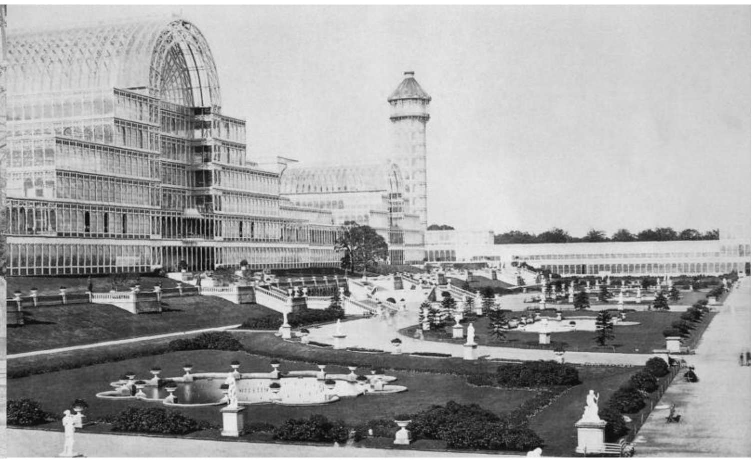



Figure 95 Left – The Crystal Fountain at the Great Exhibition of the Works of Industry of all Nations (Image: www.commons.wikimedia.org).

Figure 96 Right – The Brunel designed water towers located on the nave ends of the Crystal Palace(Image: www.commons.wikimedia.org).

refreshment stalls. Although the 1851 Exposition lacked significant new inventions, the sheer volume of industrial products, from the largest steam engine or locomotive to the smallest precision clock, made the event notable. The primary message of the 1851 Exposition was that Great Britain was the leading industrial and economic nation, a message that served as an example to other nations (Babbage, 1851; Bucher, 1851; Strutt & Tallis, 1852).

Numerous fountains were located inside the Crystal Palace (Clarke, 1852). Among them was the Crystal Fountain, which was located at the very heart of the building – the crossing of the transept and the nave (Figure 95). The Crystal Fountain consisted of a number of glass columns that rose in tapered tiers, with the main tier supporting a basin from which jets of water flowed. As the fountain rose upward, it also tapered inwards, providing the appearance of a firm, well-proportioned and solid structure, despite being made entirely from glass. Crowning the fountain was a delicately lipped central shaft from which a water jet projected. This water jet was described as having been well shaped, and that formed a lily-like flower as it descended. The resultant spray both glittered in the sunlight and sparkled in harmony with the fountain. The Crystal Fountain was manufactured by the Osler Glass Company, weighed a total of four tons, and was 27 feet high. To support this massive weight, the Fountain was placed on a basin of concrete, 21 feet in diameter, that served to catch and collect the falling spray (Clarke, 1852). One period description of the Crystal Fountain described it as having been raised upward like the splinter from an iceberg (Drew, 1852). Visitors to the Exhibition were said to have had a particular regard for the fountain, seeing it both as an object for pilgrimage and a landmark for meeting and orientation (Strutt & Tallis, 1852).

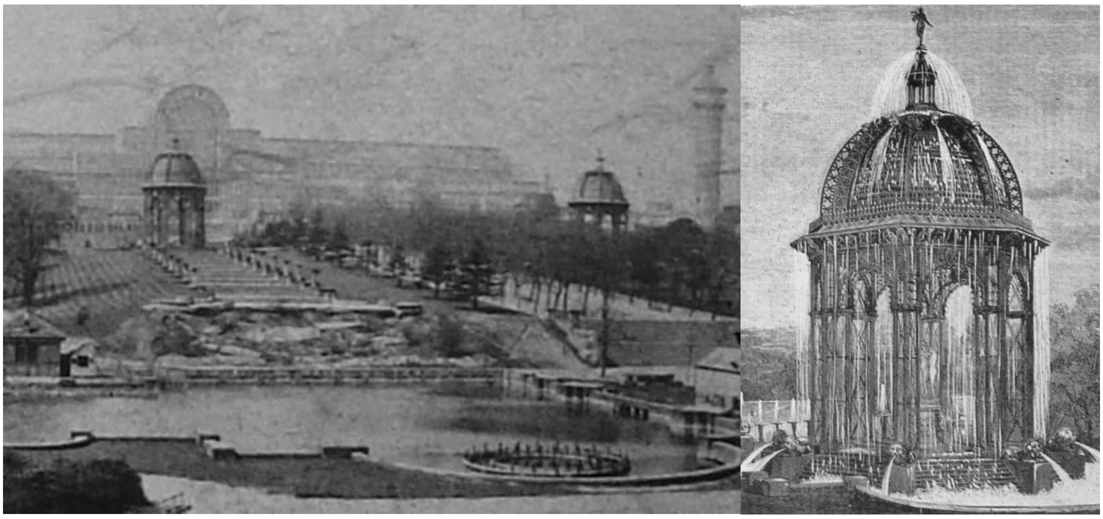


Figure 97 The Water Temples at Sydenham (Right - Chadwick, 1961; Images: Left - www.sydenham.org.uk).

When the Crystal Palace was enlarged and relocated from Hyde Park to Sydenham in 1854, Paxton proposed numerous additional water ‘features’ for both the building and the landscape on which it stood. In an effort to supply Paxton’s ambitious proposals, water tanks were needed to supply adequate water and head pressure (Chadwick, 1961). The most obvious of these ‘features’ were the two massive water towers located on the nave ends of the Crystal Palace. (Figure 96) Designed by Isambard Brunel, each had a 12-sided regular polygon plan, were 284 feet high, and had wrought-iron tanks located at the top, each of which were 47 feet in diameter and could hold 1,200 tons of water (Brunel, 1870). Apart from the Crystal Fountain, which was also relocated to Sydenham, the interior of the Sydenham Crystal Palace contained numerous other fountains and pools (Chadwick, 1961). The most notable of these interior pools were those located at the either end of the nave. The Crystal Fountain was relocated to the centre of the southern pool, or ornamental basin. The ornamental basins were constructed from a product called *granitic-breccia*, which was essentially pre-cast concrete (Routledge, 1854).

As the Sydenham Crystal Palace was placed at the summit of a hill, the associated gardens located below it on the steep slopes were designed with numerous terraces, which allowed Paxton to used water on a grand scale

(Chadwick, 1961). As such, the resultant design of the landscape featured an abundance of pools, fountains, and cascades. The Sydenham gardens were planned on a symmetrical arrangement that was centred on an axis, or Grand Central Walk, that originated from the transept of the Crystal Palace. Descending down the hill, the central axis contained a large central pool and had a number of associated water features that were arranged to both the north and south of it. Among these symmetrical water features were "…a cascade on either hand running down from a temple of glass and iron and falling into two great ornamental basins surrounded by terraced walks and with central fountain jets…" (Chadwick, 1961 p.150-1). These 'temples of glass and steel' were Sydenham's Water Temples, and were described by Chadwick (1961) as having been inspired by the almost identical structure at Chatsworth House; the Thomas Archer–designed Cascade House that sat atop the cascade designed by Grillet. The 70-feet-high Water Temples at Sydenham had a structure of cast iron and were topped with a cast-iron and glazed dome (Figure 97). A statue of Mercury, sitting atop a ball, mounted the apex of the dome. A flow of water jetted from the ball and cascaded down the dome into a gutter, which was located on the lip of the dome. As the gutter was perforated, the water then fell in a sheet over each of the arched openings below. A further collection of statues were located at the centre of the Water Temples and the falling water subsequently veiled this statuary in a transparent sheet. In addition to statues, the interior of the Water Temples also contained creeping plants. Once the water had fallen to the base of the Temple, it either flowed over the steps of the Temple or was discharged through jets, in the shape of lion's heads, which were located at the projecting angles of the plan. From here, it flowed downward over the sandstone cascade and eventually into the Grand Fountains below (Chadwick, 1961).

4.7 New York's Exhibition of the Industry of All Nations, 1853

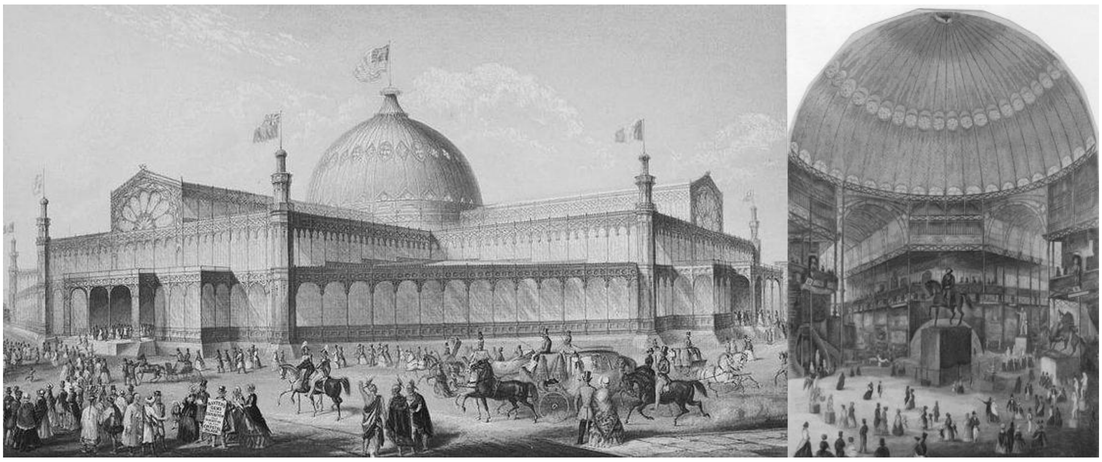


Figure 98 The New York Crystal Palace, 1853 (Images: Left - www.commons.wikimedia.org; Right - www.digitalgallery.nypl.org).

Before London held its International Exhibition on Industry and Art in 1862, New York hosted the 'Exhibition of the Industry of All Nations' in 1853. While, strictly speaking, not a World's Exhibition, the New York event was remarkable because it too had a 'Crystal Palace' (Figure 98). In general, the 1853 exhibition building's appearance and materials had a direct correlation to the Crystal Palace of 1851, thus the common naming of the building as the New York Crystal Palace. However, the ground plan, the relative proportions of the materials employed, and the construction technologies were very different, which gave it an architectural character and effect that was entirely of its own making. The general plan of the New York Crystal Palace was a Greek cross that was surmounted with a glazed dome at the intersection of the two axes. The cross was, however, only evident in the upper levels of the building. By in-filling the triangular spaces between the axes, the ground plan was in reality a regular eight-sided polygon; this allowed the provision of adequate exhibition space in the ground plan.

The principal feature of the New York Crystal Palace was a noble and beautiful dome that had a diameter of 100 feet and a height of 123 feet. Intended as an example of beauty and fine architectural effect, the dome was supported by 24 columns that were 62 feet in height. A system of wrought-iron trusses that formed a ring-beam connected the 24 columns at their apexes. This ring-beam, in turn, supported the 32 ribs of the dome proper, all secured with diagonal cross bracing. At their apex, the ribs were held together with a 20-foot-diameter wrought-and-cast-iron ring-beam. This smaller apex ring-beam in turn supported a lantern, which, in conjunction with 32 ornamental stained-glass windows that were located in the sides of the dome, allowed light into the interior. Apart from this glazed lantern, the dome was clad in tin sheeting (Silliman & Goodrich, 1854). A period description of the dome's interior referred to it as an experience that would not have failed to please and surprise the visitor because of its vast sized and extreme airiness; manifest as an "…balloon expanded and impatient for a flight into the far-off sky" (W. C. Richards, 1853 p.9). A gigantic bronze statue of George Washington on a horse was located under the dome. Additionally, two large Italian candelabra were also located to the north and south of the Washington statue (W. C. Richards, 1853). Designed by Monte-Lilla, the interior decoration of the dome, in particular the 32 stained-glass windows, created a rather conspicuous interior effect. The overall decorative scheme of the building was the responsibility of Henry Greenough, who painted the whole of the interior building in white and slightly tinted oil paints. To reach the upper floors of the building, 12 public staircases, two located at each of the four main entrances and four under the dome, were provided. Additionally, eight octagonal turrets that contained spiral staircases for private use were located in the angles of the regular polygonal ground plan (Strahan, 1876).

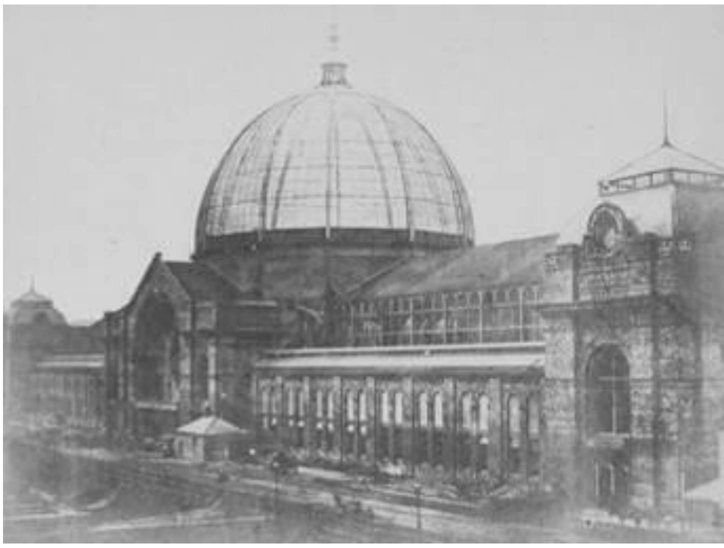
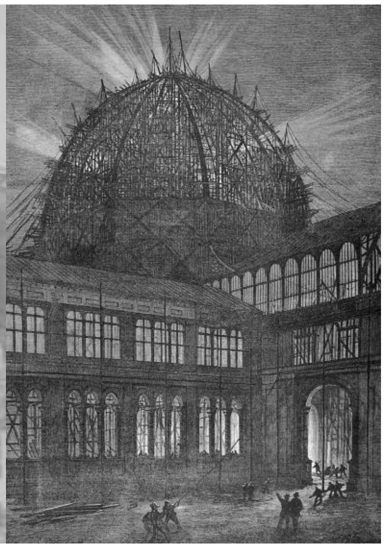



Figure 99 Left - The Exhibition Palace of the London Exhibition, 1862 (Image: www.scienceandsociety.co.uk).
Figure 100 Right – The silhouette of the dome's skeleton, under construction at night (Image: Stewart, 1862).

4.8 London's International Exhibition on Industry and Art, 1862

Following the tremendous success of the 1851 exhibition, London again hosted a World's Exposition, now called 'The London International Exhibition on Industry and Art, in 1862. In an effort to surpass the achievements of the previous exhibition, the organisers built a Captain Francis Fowke–designed Exhibition Palace of enormous proportions (Figure 99) that was entered through a highly ornate and elaborately decorated entrance hall. Once the visitor had entered, a central axis or nave spanned the entire building from east to west. Each end of the iron-and-glass nave had an octagonal hall, and these were intended as the main attractions of the Exhibition Palace. Each hall had with a large dome over it as well as transepts that spanned north and south to create the overall 'H' shaped plan. The Exhibition Palace was praised for abandoning glass as the staple cladding material of the building. However, the resultant hall, with its classical façades and two enormous glass-and-steel domes that rose 79 metres with a diameter of 49 metres, was almost exclusively ridiculed. The domes were described as timid and fragile constructions in semi-transparent, gooseberry green. Furthermore, the arrangement of placing dodecagonal domes on an octagonal plan was also condemned.

Condemnation was not solely reserved for the architecture, but also for lack of organisation. Since exhibitors were allowed to organise their allotted space as they saw fit, the French built a wall to separate their exhibit from the main nave and to gain additional display space. The unintended result of this action was that the wall became a powerful symbol of nationalist competition between states for dominance in industrial markets. The 1862 Exhibition Palace was described as having instilled a profoundly serious impression on the visitor. Rather than being a celebratory monument that expressed the idea of the intellectual gifts of British industry, it was described as being akin to a model prison, railway station, or military complex. An earlier proposal by Frederick Sang for colouring the glass domes was rejected by Fowke; however, stained-glass rose windows were installed at the ends of the naves (Beresford Hope, 1862; Laxton, 1862; Mallet, 1862). The interior iron columns of the domes were mostly coloured in dark maroon with lesser amounts of light blues and beige or vellum, which was described as extremely opulent, harmonious and majestic (Mallet, 1862).

Given the extremely restricted construction schedule of the 1862 Exhibition Palace and the domes, work was carried out day and night. At night, the ghostly silhouette of the domes' steel skeleton was lit with gas-powered lighting, which captured the attention of journalists (Bell, 1862; Godwin, 1861, 1862; Stewart, 1862) (Figure 100). The interior of the building was described as having been preferable to the exterior (Esquiros, 1862). The two large domes likewise also attracted criticism, being described by the British press as a national disgrace and as two colossal soup bowls. To compound matters, even after it opened, the Exposition's construction work was nowhere yet complete; something that would plague almost all subsequent World's Expositions. However, some notable innovations, like the Bessemer process for the production of steel and the Babbage analytical engine, were on display. The 1862 event was also the first World's Exposition to include an art exhibition. By the time the exposition closed, it had recorded some 6.1 million visitors, who had viewed 29,000 exhibitors from Britain and her colonies, along with those of 36 foreign countries (Beresford Hope, 1862; Bucher, 1863; Hollingshead, 1862; McDermott, 1862).

4.9 Paris' *Exposition Universelle*, 1867

Paris, newly revitalised and rebuilt by Georges-Eugène Haussmann, hosted the next World's Exposition, or *Exposition Universelle de Paris*, in 1867. Its organisers chose to express the global radiance of France's Second Empire under Napoleon III through the medium of technological and economic prowess. France expressed this prowess to more than 11 million visitors through two additional innovations. The first was the placement of national pavilions outside of the main exhibition hall. These pavilions were designed by the participating nation and reflected their own individual interests. The second of these innovations was the development and utilisation of a 10-part comprehensive classification system for all of human activity. Under the wider theme of the Exposition, 'The History of Labour', this system encompassed the following: *Objects d´art*; material and application in the liberal arts; furniture and domestic appliances; clothing, materials and other

Figure 101 The main Exhibition Palace, Paris, 1867 (Image: www.expositions.bnf.fr).

objects worn by people (including weapons); Industrial products and machines for producing raw materials; Instruments and processes in applied arts; foodstuffs; agricultural products; horticultural products; and objects for the improvement of the physical and moral situation of nations (Conway, 1867a, 1867b; Geissler, Grieben, & Plessner, 1868; Mainardi, 1989).

To express the French notion of equality, the main Exhibition Palace took the form of a giant oval, which offered each exhibitor a space of equal status (Figure 101). Designed by Pierre Guillaume Frédéric Le Play, the oval was further divided into four quarters and several concentric rings, which, apart from national displays, also contained artistic water spectacles, cafes and foreign restaurants. Among the most notable innovations to be presented by the 52,000 exhibitors from 41 countries was reinforced concrete. The brilliant spectacle, intensity, fraternity and equality of the 1867 Exposition, emphasised through peaceful speeches of the European nobility, however blinded the world to the ancient rivalry between nations (Conway, 1867a, 1867b; Geissler et al., 1868; Mainardi, 1989).

4.10 Vienna's *Weltausstellung,* 1873

A mere three years after the *Exposition Universelle*, France and Germany fought the Franco-Prussian War of 1870, resulting in the total reshaping of the European political and economic landscape. In 1873, Vienna hosted the next World's Exhibition under the general theme of 'Culture and Education'. In offering the first World's Exhibition in a German-speaking country, Austria chose to demonstrate an endeavour that was supported by liberal politicians and Austrian industry and agriculture, and one that demonstrated the economic and cultural revolution of the preceding 20 years. Austria chose to make manifest this phenomenon though enormous construction works in the urban context of cosmopolitan Vienna, the very heart of this social and economic miracle. The objective of the Exposition was to create a harmonious renewal, on Austrian territory, between the peoples of the world. As such, Carl von Hasenauer designed a gigantic Industrial Exposition Palace with a large domed ceremonial hall, or *Rotunde* (Figure 102), at its centre. A Machine Hall, two Agricultural Halls and an Art Hall were also built. Furthermore, numerous smaller pavilions were also erected by 35 foreign countries located in the large open areas between the main halls. In facilitating these smaller pavilions, the 1873 Exposition foreshadowed the later development of products centred in national pavilions, as opposed to large halls. A further precedent of the 1873 Exposition concerned how nations presented themselves; the western nations presented mainly technical and industrial products, while the colonies and non-industrial nations presented their indigenous peoples and associated cultures (Pemsel, 1989; von Lutzow, 1975).

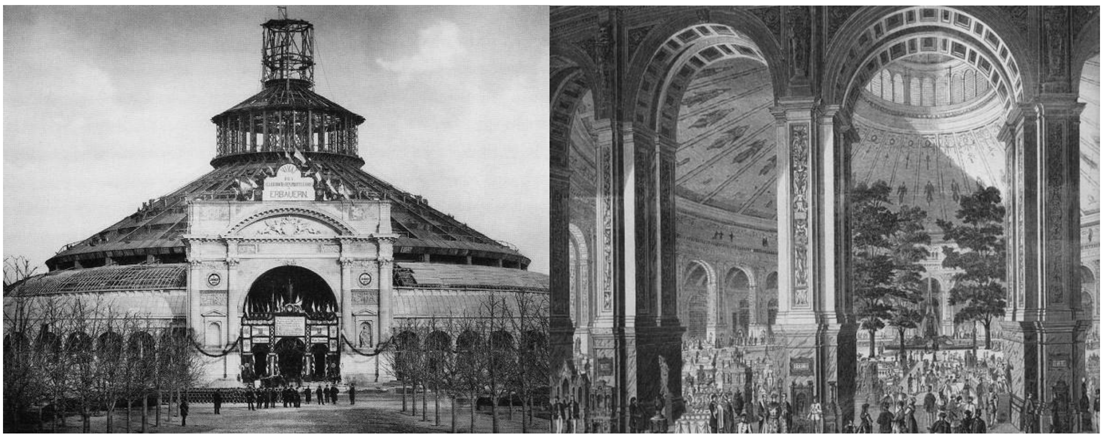


Figure 102 The *Rotunde*, Vienna, 1873 (Images: www.commons.wikimedia.org).

The *Rotunde* was engineered by Scott Russell, who based its design on a dome previously created for the London World's Exposition of 1851. This earlier design was in all probability the 'sheet iron dome' designed by Brunel from the unsuccessful Building Committee design from The Great Exhibition of the Works of Industry of All Nations in 1851. (The Building Committee included Russell, Brunel, C.R. Cockerell, Charles Barry, Robert Stephenson, etc. among others (Chadwick, 1961; Dugan, 1953)). The *Rotunde*'s dome itself comprised 32 columns that were each 24 metres high; the columns in turn supported a massive iron ring-beam that had a diameter of 104 metres. This large ring-beam supported a number of 41-metre-long radial girders that converged upward to a further smaller ring-beam that supported two apex lanterns. Zinc roofing plates were attached below the radial structural members, emphasising the structure of the dome. The lower apex lantern housed a circular viewing platform that, at 70 metres high, allowed visitors a panoramic view of both the exhibition grounds and Vienna. The diameter of this lower viewing platform was 31 metres. On top of the lower lantern and viewing platform, a further lantern was located that was itself topped with a round dome and a gilded replica of the Imperial Crown set with precious stones. The crown replica was four metres high and five metres in diameter, and formed the highest point of the exhibition at 85.5 metres. Access to the viewing platform and crown was via a hydraulic lift. Complementary decorative elements were added to the interior of the *Rotunde*. The supporting iron columns were clad masonry and linked with arches, while the underside of the dome was wrapped in canvas that was decorated with figures. Daylight also played a role, flooding into the interior through both the lanterns and large side windows (Blake & Pettit, 1873). Strahan (1876) described the canvas hanging to the underside of the dome as having been painted with coloured oil paints, and as having had 21-foot-high figures of angels at their centres. Additionally, the interior of the dome was decorated in gold and neutral colours, while the ironwork of the nave was olive green. Located at the centre of the *Rotunde* floor were four large trees from the former *Prater* Park that surrounded a highly ornamental central fountain. The floor of the fountain was lower than the rest of the building (Strahan, 1876).

According to a period description, the *Rotunde* was both the start and finish of any visit to the 1873 Exposition; a place where the visitor could prepare themselves for the impressions to come and where those impressions could be enhanced. Enlivened with a selection of exhibits surrounding a central fountain, the *Rotunde* was described as the finest example of the 1873 Exposition's architecture, with the dome and its high ring gallery that demanded the visitor's attention. The centre of the dome had a large lantern that was decorated with images of rare flowers. As the visitor could experience the dome first-hand by climbing it, the *Rotunde* offered a very different type of sensation that was certainly worth the effort (Buloz, 1873).

World events however overtook the spectacle of the Vienna World's Exposition. One result of the Prussian victory in the Franco-Prussian War was euphoric and unsustainable stock market speculation in both Germany and Austria, but also in the United States of America (Masur, 1974). With the German abandonment of silver as part of its monetary policy, the Vienna stock market experienced it first *Gründerkrach* (Founders' crash) on 9 May 1873. This initial event, which spread to the rest of Europe and the United States of America, ultimately triggered the 'Long Depression' (Angerstein, 1874). Social problems, including massive unemployment and increased cost of living, made the opulence and spectacle of Vienna World's Exposition the inevitable scapegoat, resulting in attendance figures only reaching seven of the expected 20 million visitors (www.expo2000.de).

4.11 Philadelphia's Centennial Exhibition, 1876

Philadelphia's World's Exposition of 1876, or 'Centennial Exhibition: International Exhibition of Arts, Manufactures and Products of the Soil and Mine', opened within the context of the 'Long Depression'. Thus, compared to previous World's Expositions, the architecture of the 1876 Exposition was ordinary and constrained. The planning of the Philadelphia Exposition centred on five main buildings: the Main Exposition Hall, Machinery Hall, Memorial Hall of Art, Horticulture Hall, and the Agricultural Hall. The Exposition also had approximately 200 other smaller buildings, among them buildings for 11 foreign nations; pavilions

Figure 103 The Crystal Fountain, constructed by the Washington Glass Company for Philadelphia's World's Exposition of 1876 (Image: www.nbmog.org).

for 26 of the 37 American states; restaurants; a Conservatory; corporations; and administration buildings. Both the Main Exhibition and Machinery Halls were designed as temporary structures by the architect Henry Pettit and the engineer Joseph Wilson. Constructed from a prefabricated, wrought-iron structure that was in-filled with glazed wooden frames, the Main Exhibition Hall was a conventional 'shed'-like structure that had a main nave that was 1832 feet long by 120 feet wide and 75 feet high. On either side of the central nave, further avenues were constructed that were 100 feet wide and as long as the central nave. A further two aisles were located between the nave and side avenues. In order to relieve the monotony of the plan, three cross avenues or transepts were introduced; the main one was the central transept, which was 416 feet long and 120 feet wide. Four entrances were provided to the Main Exhibition Hall; one at either ends of the nave, with a further two at each end of the central transept. Additionally, four square towers, each measuring 48 feet wide and with a height of 120 feet, were located at the corners of the building. The Main Exhibition Hall was described as having been the most imposing structure of the exhibition. Its interior decoration was described as having been handsomely executed in shades of light blue and cream, while the exterior was painted in light brown with ornamental lines of red and other harmonising hues. A raised band or music stand was located at the very centre of the Main Exhibition Hall (McCabe, 1876). The Main Exhibition Building was described as having been a ‘stupendous structure’ (Ingram, 1876).

Like the London Exposition of 1851, Philadelphia of 1876 also had a Crystal Fountain. Described as having been “…one of the most beautiful objects in the Main Building…”, the Crystal Fountain was constructed by the Washington Glass Company (McCabe, 1876 p.283). The fountain was 17 feet high and 48 feet in circumference, and was constructed entirely of cut crystal glass prisms that reflected the changing light, and, in doing so, decomposed it into all the colours of the rainbow (Figure 103). A miniature statue of *Liberty*, 30 inches high, was located at the apex of the fountain. Additionally, the lighting spectacle was continued and amplified at night, when 120 gas lights located inside the Crystal Fountain combined with the water and crystal to create a scene of beauty almost beyond imagination (McCabe, 1876). The Crystal Fountain was located at the crossing of the southern avenue and the eastern-most transepts, and executed in a manner so as to create a lasting and positive impression of Washington Glass Company (www.nbmog.org).

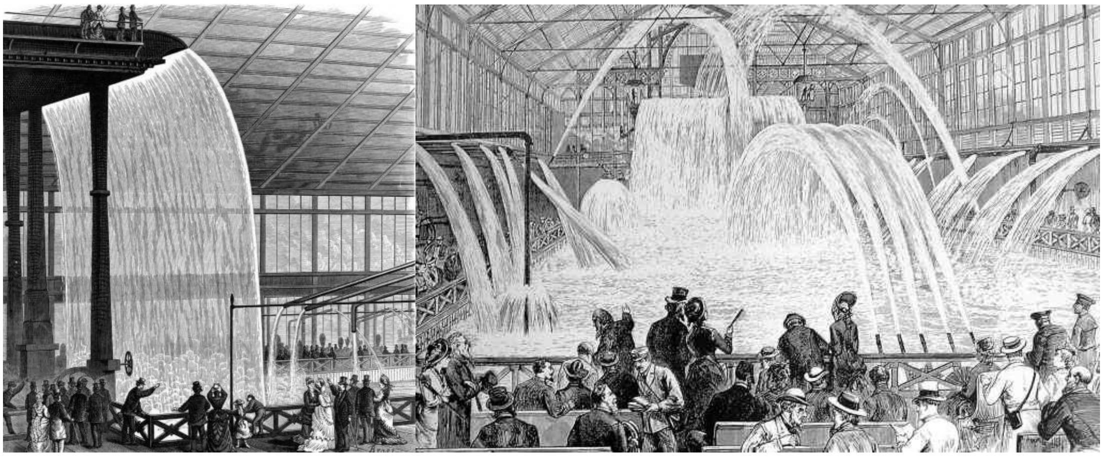


Figure 104 The Hydraulic Basin at the Philadelphia’s World’s Exposition of 1876 (Images: Munn, Beach, & Wales, 1876).

Located to the immediate west of the Main Exhibition Hall, the Machinery Hall was designed to showcase machinery in motion, such as the Corliss Engine, which stood at the centre of the Hall. The Machinery Hall was designed in a similar fashion as the Main Exhibition Hall, with a plan of naves, aisles, avenues and transepts. The main portion of the Machinery Hall was 1402 feet long by 360 feet wide. On the south side of this main portion, a Hydraulic or Pump Annex was located, which was 208 feet by 210 feet in dimension (McCabe, 1876). A hydraulic basin, 60 feet by 146 feet in plan and 8 feet deep and that held 30,0000 gallons of water, was located at the centre of the Hydraulic or Pump Annex (Figure 104). Surrounding this basin were numerous pumps, blowers, hydraulic rams, water meters and mining machinery of every kind. The pumps that surrounded the basin drew the water from it, and then discharged it in all possible manners: cascades, jets, nozzles, waterwheels, etc. (Ingram, 1876). A smaller tank, raised 40 feet into the air, was located at the south end of the basin. Into this smaller tank, two steam engines pumped 30,000 gallons of water per minute, which then cascaded down into the main pool below. The weir depth of the cascade was 4 inches and it additionally had a width of 36 feet. The effect of this cascade was said to have been exceptional and formed the principal attraction of the Machinery Hall (McCabe, 1876). Ingram (1876) described the cascade and water basin as the 'miniature Niagara Falls' of the 1876 Exposition.

Constructed primarily from timber and glass, the Agricultural Hall was located on the northern extremity of the Exhibition grounds. The parallelogram plan of the Agricultural Hall was 820 feet long by 540 feet wide, and consisted of a long nave that was crossed by three transepts (Ingram, 1876). At the crossing of the nave and central transept, a glazed cupola rose from the roof. The structure of both the nave and transepts were composed with structurally expressive, exposed-timber Howe trusses constructed in a Gothic manner. Entrances to the building were located at each end of the nave and transepts, and, like the trusses, were executed in a Gothic aesthetic, complete with two turrets and a rose window. The Agricultural Hall was artificially lit with glass lights with reflectors suspended in the trusses. A large bronze fountain was placed at the crossing of the central transept and nave. This fountain jetted water almost as high as the roof and was proposed by James McCabe as having been superior to the fountain in the Main Exhibition Hall (McCabe, 1876).

Both the Horticulture Hall and the Memorial Hall of Art were designed by Herman J. Schwarzmann. Unlike the other main buildings of the 1876 Exposition, these were intended to be permanent structures. The Horticulture Hall was an iron-and-glass structure; 383 feet long by 193 feet wide and had a height of 69 feet when measured at the raised portion of the roof or lantern. A central conservatory, measuring 230 feet long by 80 feet wide, occupied the main central part of the building. A five-feet-wide galley extended out from the central conservatory on all four sides of the building. Rising above the central conservatory was a 170 feet long by 20 feet wide lantern. On both the north and south elevations, the building had curved iron and glass forcing houses, which were 100 feet long by 30 feet wide. Dividing each of these forcing houses were three 30-by-30 feet vestibules. In the interior of the vestibules, ornate stairways led upward to both exterior and interior galleries. Below the main building, a fireproof basement was present that contained the kitchen, heating system, store and coal stores, etc. The aesthetic of the Horticulture Hall was according to the 'Mauresque style', and its exterior was painted in a multitude of colours, giving the building "…a light, fairy-like aspect, in perfect keeping with the graceful design" (McCabe, 1876 p.507). Entry to the building was facilitated on the east and west. Each entrance had blue-coloured marble steps, and ornamental tiles were contained in 80-by-20 feet terraces. Open-air kiosks stood at the centre of each entrance. To enter the building, visitors proceeded past internal stairways, through a large archway in black, white and red bricks, and then into the main conservatory. A large marble fountain, designed by Margaret Foley, was located at the very centre of the building; a tall structure, it featured several successive bowls from which water fell downward to a cistern at the base. Two 'superb' chandeliers that vividly illuminated the building at night hung from the lantern. MaCabe argued that within the context of the landscaped gardens of Fairmount Park, the Horticulture Hall stood out "…like a central jewel in the midst of a thousand gems of various hues" (McCabe, 1876 p.515). As far as decoration was concerned, Ingram (1876) concurred and described the building as a 'beautiful gem'.

Abundant examples of glazed domes, central plan features, staircases and structural expression were additionally found in the 1876 Philadelphia Exposition. The Pennsylvania Educational Hall was a separate, regular polygonal structure that had a dome at the centre of its roof. Under the dome, a central hall was located that had an outer hall or corridor running wholly around it. A further building that was planned on a regular polygonal and had a domed roof was the pavilion of the State of Arkansas. This building of approximately 80 feet in diameter was constructed almost entirely of wood. At the centre of the floor plan under the 'double dome', a bronze fountain was located, surrounded by an interior of flags and streamers and exhibits of the agricultural and mineral resources of Arkansas (McCabe, 1876). The Arkansas building was described as a spacious and impressive building that was octagonal in shape with columns being placed to the exterior. As such, the spherical ceiling had an octagonal dome that was 50 feet above the line of the floor. The construction of the building employed a large amount of glass, which made it one of the coolest and most spacious structures of the Exposition. Blue-painted arched Howe trusses supported the ceiling. The interior of the building was painted white, while the exterior was painted in pale tints that had reliefs in dark brown (Ingram, 1876).

Also planned on an octagonal plan was the Tunisian Coffee House, which was capped by an eight-sided elongated dome that was decorated red, blue, black, green and gold. The exterior of the building had small, high-set windows on each of it sides, while the roof allowed the continual circulation of air (McCabe, 1876). Ingram (1876) alternatively described the plan of the Tunisian Coffee House as having been decahedral in shape, with four of the ten sides twice as long as the remaining six. Pivoted trefoil-shaped windows supplied light to the interior that was lit in a multitude of colours through the introduction of tinted square glass window panes. The interior of the building was covered with blue and white wallpaper and the underside of the dome was decorated with scarlet coloured shields that were embossed with the Turkish crescent and stars. The interior consisted of a square room that had columns in each corner, ceramic tiles in numerous colours, and a glazed dome overhead (McCabe, 1876).

In addition to a stand-alone Moorish Villa, numerous corporations also delivered numerous 'Moorish Pavilions' inside the main exhibition buildings. In the Main Exhibition Hall, a crescent-shaped Moorish Pavilion was constructed for the jewellery firms of Tiffany and Company, Starr and Marcus, Caldwell and Company, and the Gorham Manufacturing Company. This pavilion was ornamented in rich, warm colours and had a strikingly beautiful design; supposedly, in all respects, it was the most beautiful structure at the Exposition (McCabe, 1876). In the Horticultural Hall, a further example of a Moorish Pavilion was additionally presented by the Glen Cove Company. This pavilion had an imitation stained-glass roof with tile work at it base, and, like the pavilion in the Main Building, was described as one of the most attractive pavilions in the building. In the end, 10 million people experienced the displays of over 30,000 exhibitors at Philadelphia's World's Exposition of 1876 (Strahan, 1876).

4.12 *Paris' Exposition Universelle*, 1878

In 1878, Paris hosted the 3rd *Exposition Universelle*. The site planning was centred on the *Champ Du Mars* on the banks of the River Seine. On the other side of the river, the fair grounds were extended up the slopes of the Chaillot Hill and were terminated in the newly built *Palais du Trocadéro* (Trocadéro Palace), designed by Davioud and Bourdais. Linking the two sites on either side of the river was the *Pont d'léna* bridge. The main body of the *Champ Du Mars* was occupied by a huge iron-and-glass Industrial Hall, or *Palais du Champ de Mars,* designed by the engineer Henri de Dion.

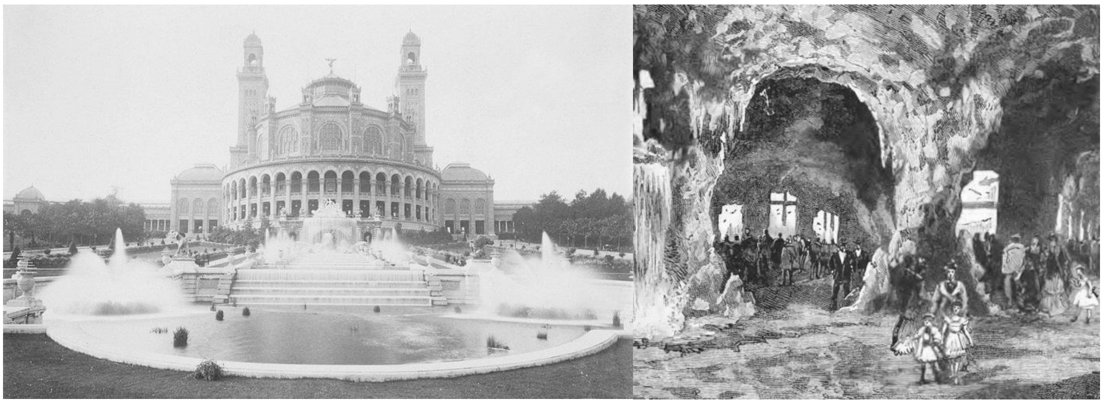


Figure 105 Left - *Palais du Trocadéro* with its waterfalls, cascades and ponds descending down the Chaillot Hill, Paris, 1878. Right – The subterranean aquarium below the *Palais du Trocadéro* (Images: Right - Delorme et al., 1879; Left - www.commons.wikimedia.org).

At the centre of the *Palais du Trocadéro* was a large circular theatre that could seat 6,000 people (Figure 105). Radiating out on either side of the theatre were two semi-circular 'wings' that enclosed the gardens below. Air was supplied to the theatre through an ingenious system of ventilation, which drew in fresh air from the catacombs below the theatre and circulated it out through a lantern on top of the domed roof. The lantern that also supplied light to the interior of the theatre had a diameter of five metres and was thus larger than the Pantheon in Rome. The main purpose of the *Palais du Trocadéro* was supposedly to serve as the starting point for a system of waterfalls, cascades and ponds that descended down the Chaillot Hill. A 10-metre-high waterfall was located at the base of the *Palais du Trocadéro*, which was supported by an arched opening that led to a subterranean aquarium that was partly decorated in mosaics. From this archway, visitors to the 1878 Exposition could experience a peculiar view of the Exposition gardens and the *Palais du Champ de Mars* through the falling sheet of water. Once over the fall, the water then flowed down a stone cascade and into a 70-metre-wide pool (Delorme et al., 1879). Furthermore, the aquarium was approximately 150 by 300 feet in dimension and was excavated from the rock below the *Palais du Trocadéro.* The galleries within the aquarium were lit only from light that first passed through the large fish tanks (Healey, 1877b).

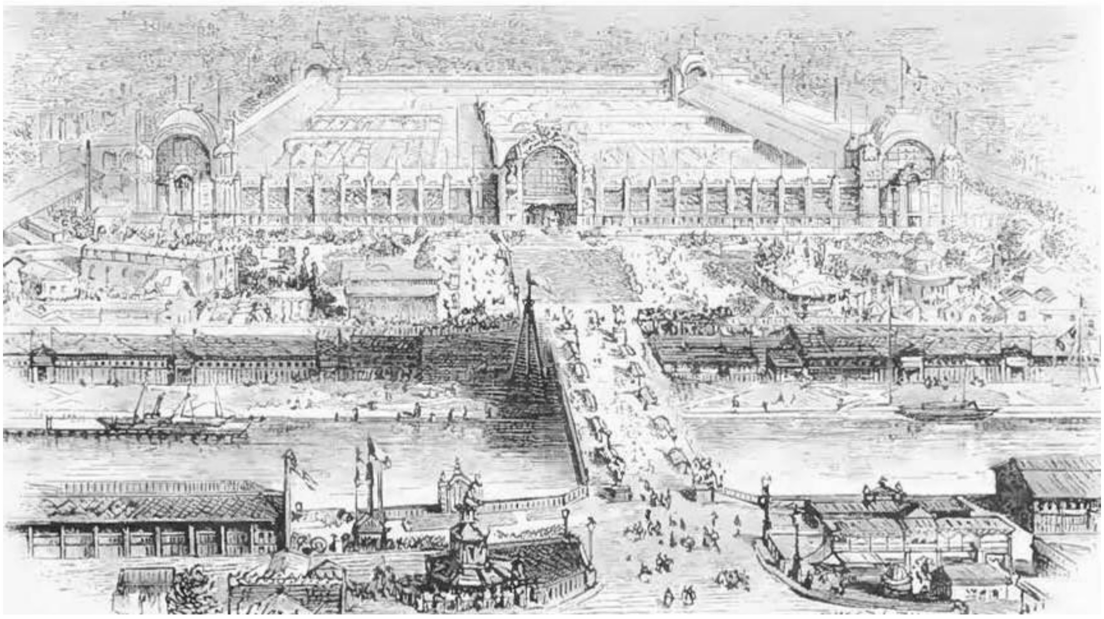


Figure 106 The *Palais du Champ de Mars*, Paris, 1878 (Image: Delorme, Blanc, de Laberge, & Harvard, 1879).

The *Palais du Champ de Mars* was a massive rectangular iron, portal-framed structure that had two outer galleries, 35 metres wide by 650 metres long (Brunfaut, 1878). These outer galleries were clad in both masonry and glazing (Figure 106). Occupying the interior of the *Palais du Champ de Mars* were six lower galleries that ran parallel to the main axis of the building and the outer galleries; an axis that extended across the *Pont d'léna* bridge and upward to the *Palais du Trocadéro.* At the very centre of the *Palais du Champ de Mars*, the *Pavillonde la ville de Paris* was located in an open air gallery. Completing each of the eight covered galleries and the open air gallery were two grand vestibules that contained the six main entrances or grand galleries/cupolas to the *Palais du Champ de Mars.* The vestibules were of great width and height, with the whole of the upper portions being glazed, creating "…the two finest galleries we have yet seen" (Healey, 1877a p.345). In contrast, the whole arrangement of the *Palais du Champ de Mars* was criticised for being too low to allow adequate views. However, in this criticism, the grand galleries/cupolas, in particular those at the four corners of the immense *Palais du Champ de Mars*, were excluded: "The four especially admirable situations for display are under the domes at the four corners of the building, and these are respectively occupied by the English colonies, the Dutch colonies, a statue of Charlemagne and a trophy of French metallic work—notably, large tubes for telescopes" (Knight, 1878 p.403). The grand vestibules were described as having been 1,000 feet long by 80 feet wide, with clerestory windows on both sides, the glazing of which was described as having been executed in geometric patterns with tinted glass, creating a 'fine effect' (Healey, 1878).

Like the Centennial Balloon at the Philadelphia's World's Exposition of 1876, a further object of interest at the 1878 Exposition was *the Le Grand Ballon* (Grand Balloon) designed by Henry Giffard. Filled with hydrogen gas, the balloon had a diameter of 56 metres and could lift 25 tons. The huge sphere of the balloon was connected via a rope net to a circular passenger car, which was six metres in diameter and could accommodate 40 to 50 passengers. Two steam engines were connected to a 600-metre length of rope and could raise and lower the balloon high above Paris and the 1878 Exposition (Tissandier, 1878). While not located on the Exhibition grounds, but, rather to the east at the *Palais des Tuileries* (Tuileries Palace), the balloon with its intrepid travellers was the envy of the world with its views of Paris and its grand exhibition (Delorme et al., 1879).

4.13 Paris' *Exposition Universelle*, 1889

In the 1880s, a specific trend toward industry-based exhibitions developed. Some examples include the First International Exhibition of Electricity, hosted in Paris in 1881; The International Cotton Exposition in Atlanta, Georgia, in 1881; the *Exposition Universelle Coloniale et d'Exportation Générale* (Universal Exposition of the Colonies and General Exports), in Amsterdam in 1883; and the World's Industrial and Cotton Centennial Exposition, in New Orleans in 1884. However, large holistic international events were still prevalent, with examples being the *Exposition Internationale d'Anvers* (International Exhibition in Antwerp) in Antwerp in 1885; the *Exposición Universal* (Universal Exposition) in Barcelona in 1888; and the *Exposition Universelle* (Universal Exposition) in Paris in 1889.

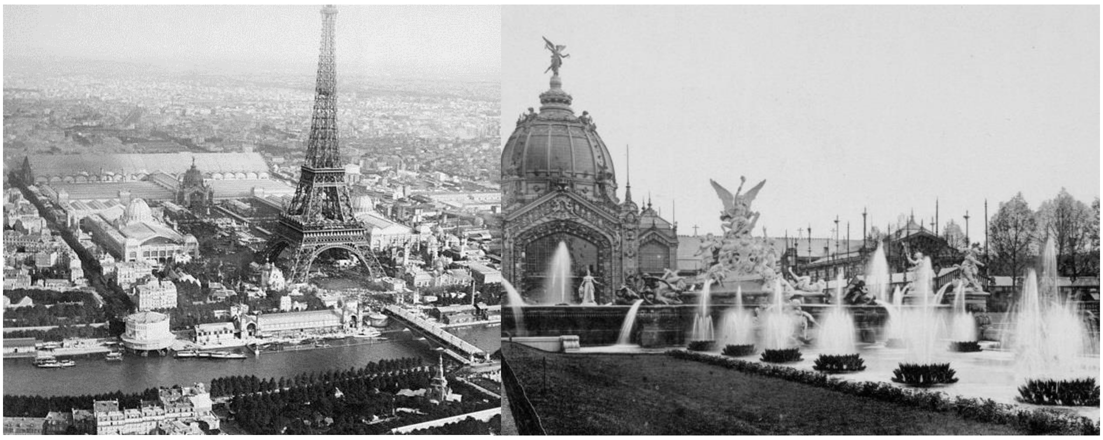


Figure 107 The Paris *Exposition* Universelle, 1889. Right – the main exhibition grounds on the *Champ de Mars*, centred on the Eiffel Tower. Left - The *entrée d'honneur* and fountains (Images: www.commons.wikimedia.org).

Undoubtedly, the 1889 Paris *Exposition Universelle* was best known for the Eiffel Tower and the *Galerie des Machines*. The main location of the Exposition was the *Champ de Mars*, extended across the Seine and upward to the *Palais du Trocadéro*. Additionally, the Exposition's agricultural buildings extended eastward along the *Quai d'Orsay*, and terminated at the *Esplanade des Invalides* with an exhibition of the French colonies. Planning of the *Champ de Mars* consisted of the construction of a series of U-shaped exhibition halls. The arms of the 'U' consisted of the *Palais des Arts libéraux* and the *Galerie Desaix* with the parallel *Palais des Beaux-Arts* and the *Galerie Rapp*, while the base of the 'U' consisted of the *Palais des Expositions diverses* and the *Galerie des Machines.* At the centre of the 'U' plan, the Eiffel Tower served to form a southern gateway to the *Pont d'léna* bridge. As with the 1878 Exposition, in the 1889 Exposition, the main central axis extended down from the *Palais du Trocadéro,* across the *Pont d'léna*, continued under the Eiffel Tower and through the *Palais des Expositions diverses*, finally terminating in the *Galerie des Machines.* A massive central domed portal was erected to mark the main axis' entrance into the *Palais des Expositions diverses* (Exposition Universelle de Paris, 1889; Monrod, 1889). The dome was considered as the *entrée d'honneur* (grand entrance), as it was the most admired architectural aspect of the Exposition (Blaine, 1890). Two additional, glazed central domes, one each over the *Palais des Beaux-Arts* and the *Palais des Arts libéraux*, were also present at the 1889 Exposition (Figure 107).

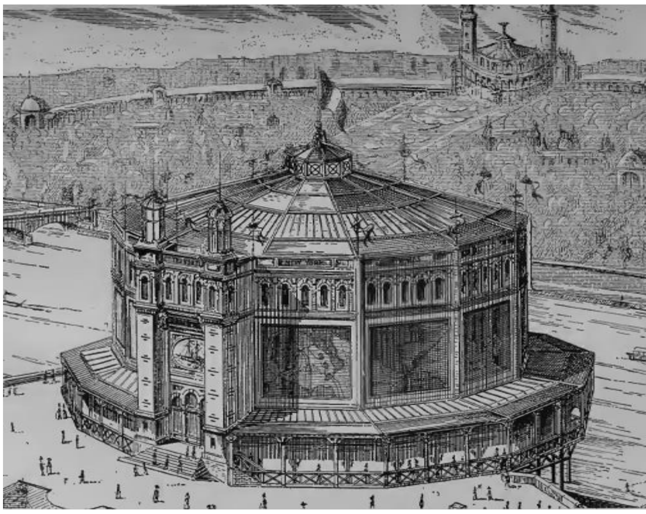
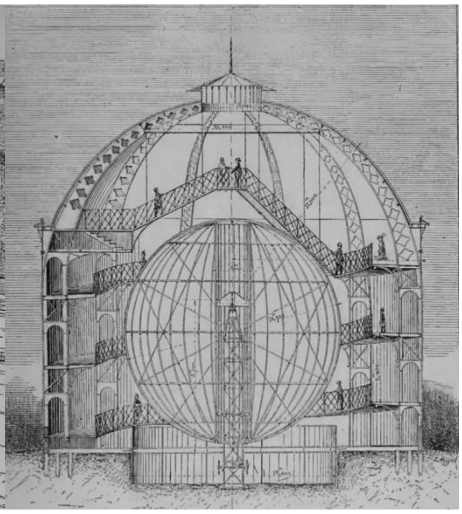



Figure 108 Left – The pavilion for the *Compagnie Transatlantique*, Paris, 1889 (Image: Exposition Universelle de Paris, 1889).
Figure 109 Right - The earth globe, Paris, 1889 (Image: Exposition Universelle de Paris, 1889).

Also exhibiting at the 1889 Paris Exposition was the *Compagnie Transatlantique* (Transatlantic Company). Its pavilion was planned on a regular polygon located on the *Quai d'Orsay* to the east of the Eiffel Tower (Figure 108), and in it, the visitor could experience all the luxury and comfort of a transatlantic sea voyage, but without any of the danger. This pavilion featured exhibits of cabins and engine rooms, a bridge and lifeboats together with images of the Company's main destinations (Exposition Universelle de Paris, 1889).

A further pavilion of interest was located on the western boundary of the *Champ de Mars;* this modest building housed a 40-metre-diameter globe of the earth (Figure 109). This pavilion was capped with a simple dome and lantern apex configuration. However, the main attraction of this domed pavilion was not the globe itself, but rather the spiral staircase that surrounded it. Of additional interest was an Otis elevator that was installed to mimic the axis of the earth. To access this elevator, visitors would descend via a helical ramp into the entrance of the lift; once in the lift, visitors would ascend upward through the globe from the south to north poles (Exposition Universelle de Paris, 1889).

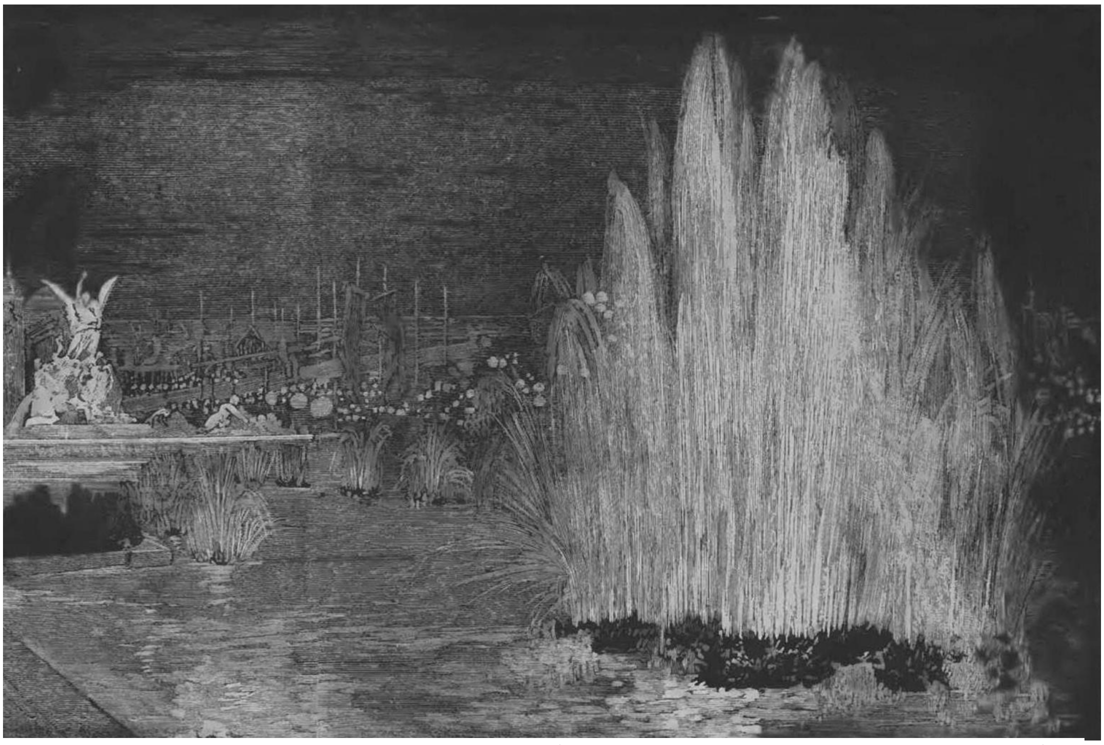


Figure 110 *Les Fontaines Lumineuses*, Paris, 1889 (Image: Exposition Universelle de Paris, 1889).

Les Fontaines Lumineuses (Luminous Fountains) were a further defining feature of the 1889 *Exposition Universelle* (Figure 110). Located in a number of large pools and fountains directly beneath the Eiffel Tower and between the *Palais des Beaux-Arts* and the *Palais des Arts libéraux,* the *Fontaines Lumineuses* were conceptualised as France illuminating the world and surrounded by Science, Industry, Art and Agriculture. Countan designed the fountains between the *Palais des Beaux-Arts* and the *Palais des Arts* and they consisted of a large central motif, with four large fountains supplying a large flow of water. Immediately adjacent to the central motif were eight smaller motifs, each with 10 fountains, all of which were surrounded by numerous smaller fountains. In total, the whole fountain system could project approximately 500 litres of water per second. The true novelty of the *Fontaines Lumineuses* however lay in its ability to be lit at night by coloured, electric lighting, creating a sparkling display reflected in the cascades and ponds. Located directly below the Eiffel Tower, the grand fountain was built and sculptured by de Saint-Viadl and was lit by four arc lamps (Monrod, 1889). Paris' illuminated fountain spectacle was however predated by previous examples in Edinburgh and Glasgow (Exposition Universelle de Paris, 1889).

Figure 111 The American Edison Company's central display object of 20000 incandescent electric light bulbs, Paris, 1889 (Image: The American Commission, 1889).

The greatest novelty of the Paris Exposition of 1889 was however that created by electricity, since it was the first international exposition since the practical beginning of the industry (Hering, 1893). Still a relative novelty, the extensive use of electrical lighting transformed the Exhibition grounds into a true 24-hour experience. As the most visible example, the Eiffel Tower was equipped at its apex with both a fixed revolving light and numerous search lights. These lights probed the darkness of night in all directions with coloured light (Monrod, 1889). Furthermore, the largest exhibitor at the Paris Exhibition was the American Edison Company. The exhibit of the Edison Company won the highest award of the Exhibition, namely the 'Grand Prize', which was personally presented to Thomas Edison by the French President Carnot. Among the display of objects as diverse as phonograph recorders and telephones, Edison also presented a mammoth 40-foot-high display of 20,000 incandescent electric light bulbs in various colours (Figure 111). At the apex of this display and standing on a large pedestal was a giant model of a light bulb that contained 13,000 individual 16-candle-power light bulbs. To light this massive model, a ‘filament’ of 60 ‘blood red’ 150-candle-power electric bulbs were arranged on a two-inch gas pipe (The American Commission, 1889).

If judged solely on exhibitor and visitor numbers, 55,000 and 28.15 million respectively, the 1889 *Exposition Universelle* was undoubtedly a huge success (R. Johnson, 1897). However, it was here that the nature of World’s Fairs started to transform from showcasing machines and industrial products to emphasising both the effects and characteristics that could be created with new technologies, such as electricity.

4.14 Chicago’s World’s Colombian Exposition, 1893

At the end of the 19th century, the seminal event that shaped wider American and specifically Chicago’s sentiment was the World’s Colombian Exposition of 1893. A 2.9 square kilometre area known as Jackson Park on the shores of Lake Michigan was dedicated as its site. The Exposition itself was intended as a celebration of the 400th year anniversary of Christopher Columbus’ discovery of America. Frederick Law Olmsted, in conjunction with the architectural form Burnham and Root, developed a site plan that divided the Exhibition grounds through the use of large, artificial water features. At the heart of this plan was a large Central Basin that contained the Columbian Fountains and the Statue of the Republic, at either end. At the western end of the Central Basin, a smaller Canal intersected the basin at a right angle. The main buildings of the exhibition were grouped around the Central Basin area, alternatively known as the Court of Honour, and included Machinery, Agriculture, the Railway Station, Mines, Electricity, and Manufacturing and Liberal Arts. These buildings were commonly referred to as the White City because of the overwhelming use of white paint on almost all of their exterior façades. Additionally, the majority of the White City and the other larger structures at the Exposition of 1893 were constructed in the neoclassical Beaux-Art style dictated by the Exposition’s management and architects. The South Pond was constructed at the southern end of the Canal. Centred on this pond were mostly agricultural exhibits such as Leather, Forestry and Livestock. At the northern end of the canal, a further large Lagoon was constructed, surrounded by the smaller exhibition buildings, which included the following: Transportation, Choral Building, Horticulture, White Star Line Building, Women's Building, Fisheries, and the Government Building of the United States of America. Again at the northern end of the Lagoon, a third and last North Pond was created that formed the centre of a group of buildings for foreign nations, American states and Art Galleries. An amusement area known as the Midway Plaisance protruded outward on the Western extremity of the main exhibition grounds, just behind the Women's Building (Fred Klein Company, 1894; R. Johnson, 1897; Truman et al., 1893).

Figure 112 The Moorish Palace at the World's Colombian Exposition, 1893 (Images: www.commons.wikimedia.org).

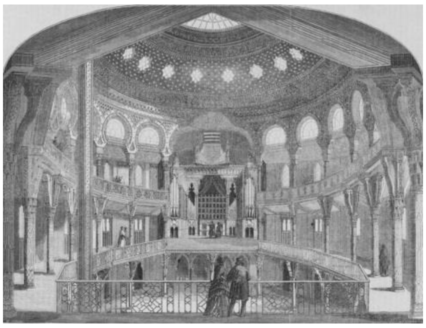
The Midway Plaisance was one of the major innovations introduced at the World's Colombian Exposition. Considering that the attractions of the main fair grounds were regarded as a serious endeavour, the Midway was intended from the onset as light entertainment and a necessary distraction. As such, the Midway was designed to incorporate rest, comfort, refreshment, picturesque displays, foreign cultural exhibits, and, above all, amusement. However, this is not to argue that the organising committee was totally at ease with the inclusion of these frivolous, but necessary, distractions. Thus, the chosen location was the narrow allocation of land outside of the main grounds in an intentional effort to prevent *"*…jarring contrasts between the beautiful buildings and grounds on the one hand, and the amusing, distracting, ludicrous, and sometimes noisy attractions of the Midway" (R. Johnson, 1897 p.75). In an attempt to mirror the success of the Eiffel Tower at the 1889 World's Exposition, a steel tower of similar height was initially proposed for inclusion in the Midway. However, this plan never came to fruition; instead, a design by George W.G. Ferris for a 250-feet-diameter 'Ferris wheel' was built (R. Johnson, 1897). Regardless of the Midway's general 'character', it did contain some structures of interest to this study; principal among these were the exhibits displaying interpretations of the Orient.

Located on the eastern end of the Midway near the Ferris wheel, the Moorish Palace contained a garden of palms, a chamber of horrors, a labyrinth, a room of mirrors, a waxwork show, and a theatre of optical illusions (Johnston, 1897) (Figure 112). Additionally, the Moorish Palace was quoted as having contained a *camera obscura*; depictions of trips to the moon and Switzerland; and the exhibit and sale of native goods (Handy, 1893). The chamber of horrors in the Moorish Palace contained the French guillotine '*La Dijonnaise'*, the very object that ended the life of Marie Antoinette in October of 1793 (Truman et al., 1893). Arguably, the best description of the Moorish Palace came from Flinn (1893): Designed by the German émigré architect August Fiedler, the Moorish Palace had a palm garden surrounded by a continuous labyrinth that was one of the leading attractions of the Midway. Modelled after that in the Alhambra Palace in Granada, Spain, the gardens presented an illusion of boundless space that was created through the clever use of mirrors. The gardens presented a:

> …fairyland filled with startling surprises. The first thing which impresses the observer within the palace are the elaborate decorations. He [sic] is in a maze of Alabaster-like columns, stretching away in long vistas. The columns are covered with curious hieroglyphics and support a dome and arched ceiling reflecting from its mother of pearl a softly radiant light. Standing on the tiled floor of mosaics, the visitor may cast his eves upward, and admire the

> delicate filigree in gold, purple and silver, sweeping in flowing lines, here and there gracefully crossing and forming an intricate net-work of beautiful curves. From the arch depend pretty little stalactites, in gilt, producing a very pleasant effect on the pearly back-ground (Flinn, 1893 p.34-5).

Once the visitor had exited the ‘Magic Maze’, the next experience was a ‘bottomless well’ into which people would satisfyingly gaze. Following this experience, the visitor would then step over a ledge of rock and into a cave. “The walls of the cave glitter like so many diamonds, and as you turn your eyes upward the sight of a group of devils makes you start. There, in a hole in the rocks above, a lot of red imps are staring at you” (Flinn, 1893 p.35). At this point, it should be noted that the palm garden and its labyrinth were in fact an optical illusion contained in a mirror maze; the very same object as the ‘Magic Maze’. As Flinn (1893) continued, next was a flight of ascending stairs that led to a ‘gigantic



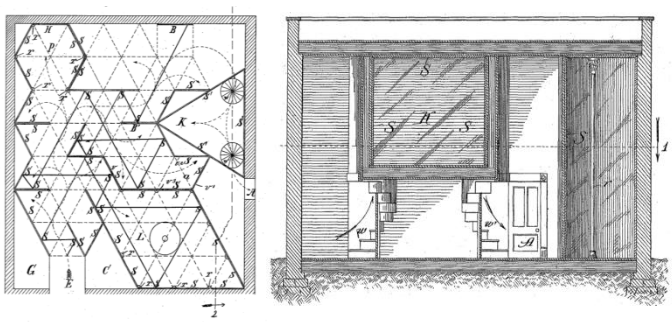


Figure 113 Left – The Royal Panopticon of Science and Art, Leicester Square, London (Image: Godwin, 1854).
Figure 114 A plan and section from the 1888 Patent by Gustav Castan for the mirror maze (Images: Castan, 1895).

kaleidoscope’ where the visitor experienced the sensation of being surrounded by a ‘thousand people’. From this point, the visitor then progressed upward via a broad staircase to the upper floor of the Moorish Palace. On the upper floor, the visitor could experience fine art obtained from the ‘Berlin Panopticon’. Apart from the fine art, other experiences on the upper floor of the Moorish Palace included an exhibition of the guillotine ‘*La Dijonnaise*’; three ‘optical illusions’, which were skilfully executed and afforded the visitor ‘food for thought’; and theatres in which respectable presentations were given (Flinn, 1893).

The designer of the palm gardens and associated labyrinth in the Moorish Palace was Gustav Castan (Unknown author, 1893). He and his brother, Louis

Castan, were the owners of the Panopticon attraction in Berlin, which first opened in 1873. When the Panopticon moved to its new location at the premises of the Pschorr Brewery at 165 *Friedrichstraße* in 1888, a mirror maze was installed (Saward, 2008). A period description of this installation, or *Castan's Irrgarten* (Castan's Maze), portrayed it in a similar metaphorical language as Flinn (1893), stating that it was complete with an experience of the cathedral of Cordoba and the Alhambra in Granada (Castan & Castan, 1900).

Gustav Castan was granted a French patent (September 8, 1888, No.192868) for the mirror maze in 1888, and an American patent in 1895 (Castan, 1895). A comparison of this patent and the progression of the journey as outlined by Flinn (1893), i.e. from 'Magic Maze' to 'bottomless well' then onward to the 'cave' and finally into the 'monster kaleidoscope', are essentially identical. In the patent, a Mirror Maze was to be erected in a building or room. To experience the Mirror Maze, the visitor would enter, pay a cashier and then deposit their cloaks. Having entered the Mirror Maze proper, the first impression the visitor would have is the sensation of being at the end of an immensely long avenue. This impression was in fact created by an image that was placed at the other end of the room and then reflected back to the visitor off numerous mirrors arranged as equilateral triangles. Once the visitor had entered the labyrinth of the Mirror Maze, further experiences became apparent; that of being either in the Lion Courtyard of the Alhambra Palace, or the experience of a lush tropical garden. In reality, these experiences were created by distinct compartments in the Mirror Maze that were accordingly decorated. Once the visitor had found their way through the Mirror Maze, they would then have entered a compartment where the initial image, i.e. that of the immensely long avenue, was located. This compartment, while having some vertical surfaces covered with mirrors, was not entirely covered with mirrors. In this compartment, the visitor became aware that they have exited the Mirror Maze proper. Additionally, in this compartment, the visitor was then exposed to a spiral staircase that led upward to an experience of being in large crowd. In reality, this experience was created by the visitor entering a raised kaleidoscope, a regular tetrahedron arranged in the form of a triangle (Figure 114). Inside the kaleidoscope, the walls and roof were mirrored; the mirrors were connected together in a manner so that joints were not visible. Once the visitor had completed this experience, they would have then exit the raised kaleidoscope via another descending spiral staircase. At the bottom of this spiral staircase, the visitor would then enter a final compartment and then exit the building or room entirely.

A panopticon was however not a new concept. In the early 1850s, the Royal Panopticon of Science and Art was constructed in Leicester Square, London (Figure 113), with the intention of showcasing the best of scientific and artistic endeavours. A 97-feet-high central rotunda was the primary attraction of the Royal Panopticon. Surrounded by three tiers of viewing galleries, the rotunda has an illuminated fountain that was supplied with water from an artesian well. When in operation, the fountain could project a water jet to the underside of the dome that crowned the rotunda. The underside of the dome was decorated in a colourful array of glass, alabaster and enamelled slate, reportedly creating the most splendid room ever constructed for scientific and artistic endeavour (White, 1854).

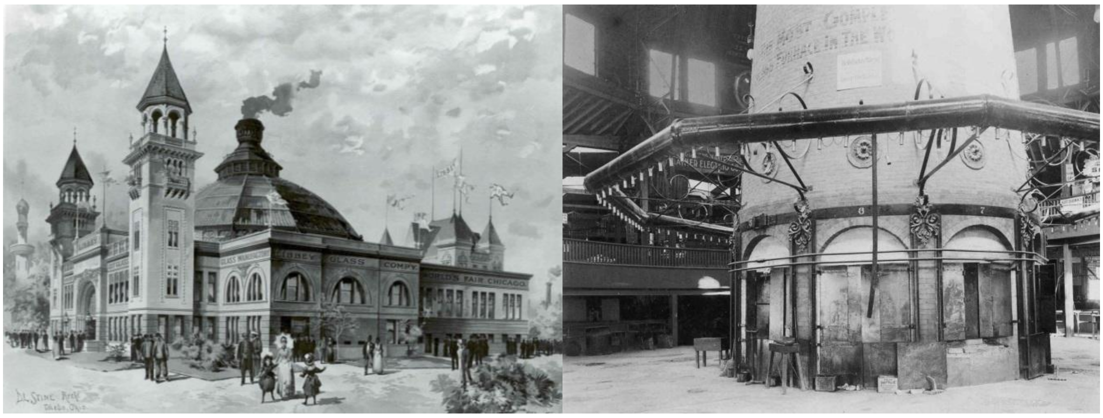


Figure 115 The Libby Glass Company’s pavilion on the Midway Plaisance, Chicago, 1893 (Images: www.utoledo.edu).

A building for the Libby Glass Company also occupied a site on the Midway Plaisance at the Exposition of 1893. This building was proposed as the most beautiful of the Midway; based on a rectangular plan with two towers located at each corner of the main street façade, it had a prominent dome with a chimney at it centre (Figure 115). Inside the building, the walls, dome and ceiling all glittered and gleamed in sparkling, prismatic colour that emanated from the myriad of displayed glass products. The main entrance of the building led onto a large semi-circular room that had a large melting furnace located in the middle. This furnace was 100 feet high and adopted the form of a truncated cone that was 25 feet in diameter (Flinn, 1893).

An exact copy of the captive balloon of the 1889 Paris *Exposition Universelle* was also located on the on Midway Plaisance. This balloon could ascend 1,493 feet into the air, this figure being the same number as the date of Columbus' discovery of America. Views from this balloon allowed the visitor to

> …see the great buildings of the Exposition. Domes, towers, spires, winged Victories, bathed in light, waters flashing in the rays of an unclouded sun; so beautiful is the view that it seems hardly real. We are floating over fairy-land (Shepp, 1893 p.524).

Domes were to be found over many of the main buildings and examples included the Administration Building; the Government Building of the United States of America; the Fisheries Building; and the Fine Arts Building. However, because almost all of the domes had a neoclassical aesthetic, the most modern dome at the Exposition was that over the Horticulture Building. This building was designed by

Figure 116 The Horticulture Building and the tropical mountain at the World's Colombian Exposition of 1893 (Image: Rand McNally and Company, 1893).

the prominent Chicago architect William Le Baron Jenny. The plan of the Horticulture Building was based on a rectangle that was 1,000 feet long by 287 feet wide. The resulting arrangement creating the grandest and largest building ever erected for a horticultural exhibition (Handy, 1893; Truman et al., 1893). Located at the centre of this plan was an imposing glazed dome that was 114 feet high and 187 feet in diameter. The interior of the dome was both artificially heated and moistened. Beneath the central dome, a 'miniature tropical mountain' was constructed that contained an extensive cave, constructed by Keith & Allabaugh, in its base (Johnston, 1897) (Figure 116). Several cascades, which were described as having sparkling water that leapt from rock to rock beneath the foliage of tree ferns, palms and other tropical vegetation, ran down the sides of the mountain. The entire cave below the mountain was constructed of (real) stalagmites, stalactites and quartz crystals. With the aid of artificial electric lighting, the created effect was both pleasing and dazzling (Handy, 1893). The cave was described as being a reproduction of one of the 1400 chambers of the Mammoth Crystal Caves of South Dakota. Owing to its exterior, luxurious tropical growths, and interior that displayed a "…enchanted chamber glittering with diamond-like stalagmites and other forms of crystal", the beauty of the 'miniature tropical mountain' and cave were one of the principal features of the Horticulture Building (Rand McNally and Company, 1893 p.114).

Figure 117 Left - The Falconnier glasshouses to the north of the Horticulture Building at the World's Colombian Exposition of 1893 (Image: Rand McNally and Company, 1893). Right – The Falconnier glasshouse first published in the journal *La Nature* in 1893 (Image: Tissandier, 1893).

Numerous smaller horticultural glasshouses were additionally located on the western end of the Horticulture Building. In addition to these examples, 25,000 square feet of auxiliary glasshouses were also constructed in close proximity to the Horticulture Building. All of these glasshouses were constructed by leading firms, such as Lord and Burnham, Hitchings and Company, and the New York Central Iron Works (Handy, 1893). Also among these glasshouses were two unique pavilions erected by Gustav Falconnier, whose construction employed his patented blown Glass Building Blocks (Rand McNally and Company, 1893) (Figure 117). First patented in France in 1886, Falconnier also subsequently patented his design in the United States of America in 1889 (Falconnier, 1889). The larger of these pavilions at the Chicago Exposition of 1893 appeared very similar to an example first published in the journal *La Nature* (Nature); this example was approximately 8 meters long by 3.8 meters wide and had a glazed curved span roof, constructed entirely of patented Falconnier Glass Building Blocks (Tissandier, 1893).

Art Glass was also to be found at the Chicago Exhibition; for example, the Midway had a pavilion that housed the Parisian Glassware Company. In this pavilion, glass spinning was demonstrated and finished products were also sold. Furthermore, the Venice-Murano Glass Exhibit occupied a Gothic-styled building that was extensively inlayed with glass mosaics; here too glassware was both made and sold to visitors (Flinn, 1893). The Texas Building had a central assembly hall that had art glass skylight in the ceiling, with a mosaic of the Texas Star at its centre (Handy, 1893; Truman et al., 1893). In the Manufactures and Liberal Arts Building, the Tiffany Glass and Decorating Company constructed a pavilion that had a triple-arched entrance, with a 100-foot-high saffron-coloured Doric column that had a globe and golden eagle at it apex. The interior of the Tiffany pavilion was divided into three rooms, the largest of which exhibited a Byzantium-inspired chapel, with a

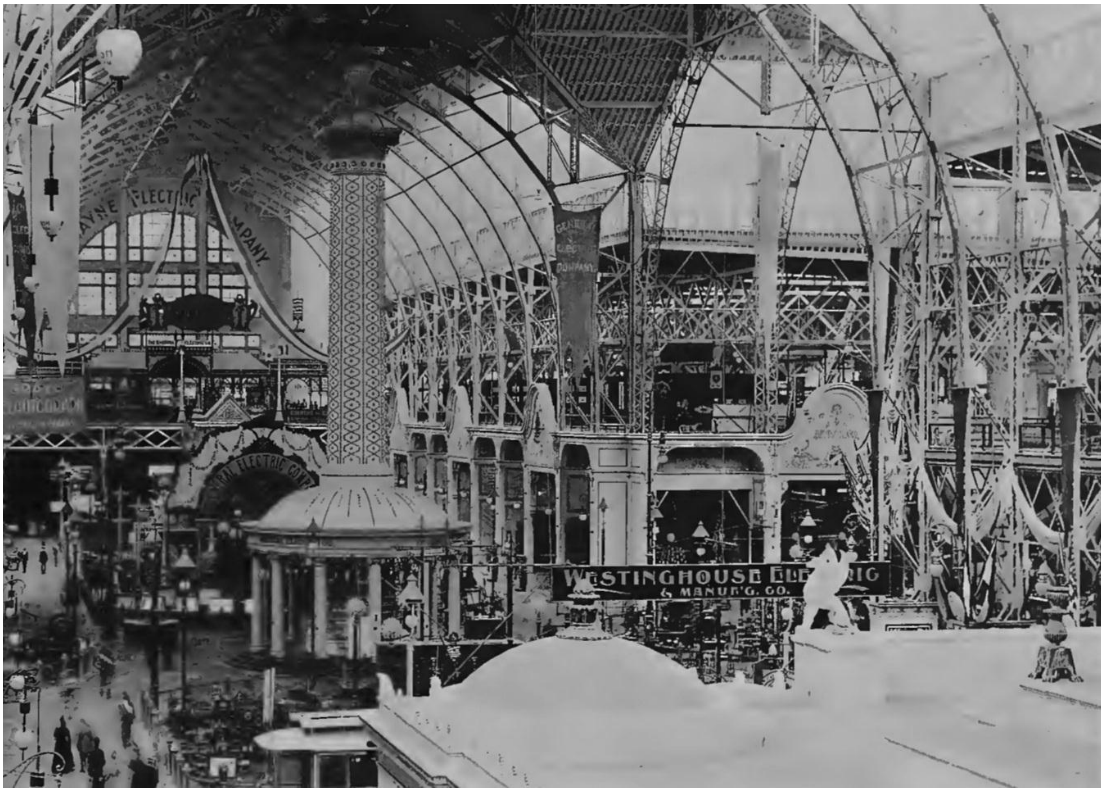


Figure 118 The Electric Tower at the World's Colombian Exposition of 1893 (Image: Arnold & Higinbotham, 1893).

wonderful altar set beneath triple mosaic covered arches. The floor of the chapel was covered with wrought-glass mosaics, as were the steps to the altar and the front of the altar itself. Additionally, the columns were also covered with glittering mosaics. The interior of the chapel was considered as artistically beautiful and exceedingly opulent (Truman et al., 1893). A large ornate lamp, constructed from thick, deep-green glass globes and faceted like emeralds, hung from the ceiling in the chapel. In addition to this light, the Chapel was also lit by coloured glass windows that were constructed from the mosaic system, where light and shade effects were achieved not by paint but by differences in the surface finish of the individual glass pieces or mosaics. So popular was the Tiffany Chapel that, during the exhibition, 1.4 million people visited it (Johnston, 1897).

Also exhibited at the Chicago Exhibition of 1893 was an Electric Tower, which was the joint pavilion of both the Edison Electric Company and the Phoenix Glass Works. Located at the centre of the Electricity Building, at the crossing of the nave and transept, the Electric Tower represented the crowning achievement of Edison, who had made the incandescent electric bulb his life’s work. So important was the Electrical Tower to the Electricity Building that the official opening of it was delayed until the tower was complete (Truman et al., 1893). The base of the tower consisted of a colonnade constructed on a circular plan, and a dome was placed above the colonnade that contained the tower proper (Figure 118). Contained within the outer extremities of colonnade was an exhibit of numerous electric fittings manufactured by the Phoenix Glass Works (Arnold & Higinbotham, 1893), while the interior extremities of the tower contained the electrical distribution and control equipment for the tower above. The shaft of the tower was illuminated by thousands of coloured incandescent light bulbs supplied by the Edison Company. The bulbs were mechanically controlled and could be flashed in harmony with accompanying music. Like the Edison pavilion at the Paris Exhibition of 1889, the apex of the tower consisted of a replica of a giant Edison incandescent light bulb. However, unlike the Paris example, this model was constructed from approximately 30,000 prismatic crystals that were illuminated from within. A marvellous effect was created through a “…combination of kaleidoscopic beauties…” by this “…graceful luminous shaft…” which was “…over eighty feet of solid brilliancy” (Truman et al., 1893 p.358-60).

This electrical brilliance was however not exclusive to the Electric Tower and the Electricity Building, although the Electricity Building was the only building provided with sufficient quantities of electric lighting to allow visitation during the night (R. Johnson, 1897). To provide electric lighting to the Manufactures Building, five large electroliers, or coronas, were installed 150 feet above the floor. A corona was essentially a large circular light feature constructed from light angle iron, with light bulbs suspended from it. The largest central corona was 75 feet in diameter and had a total of 102 bulbs, while the remaining four coronas were 60 feet in diameter and had 78 bulbs. The character of the resultant light was pleasing, soft and mellow (R. Johnson, 1897). Additionally, according to Johnson (1897), the most novel application of electric lighting at the Exposition was to the tanks in the Fisheries Building, where the aquariums were illuminated through the use of invisible lamps that shone through the water. However, the most brilliant electric lighting was that of the Gallery of Fine Arts, where bulbs that were only eight inches apart were placed onto nearly two miles of reflecting screens. Thus, the lighting of the Gallery of Fine Arts was said to have been both the most difficult and beautiful of any lighting that had ever been executed. However, the

> …most charming electrical effects were produced in the evening as the twilight deepened. All along the margins of the great basin lines of incandescent lights flashed out of the shadows, and were answered by other lines along the cornices and pediments of the great white palaces. Long wreaths of light climbed the ribs of the Administration Dome and twined themselves into a brilliant coronet at its summit. Arc lights flamed everywhere like mimic suns and with incandescent bulbs more numerous than the stars were reflected in rippling radiance on the dancing waters of the lagoons. Then great solid beams from the search-light mirrors smote the air and, as the swung, rested for a moment on the quadriga or the MacMonnies fountain, on the winged figures of Machinery Hall or on the groups on the Agriculture Building, on the 'green sward before the Liberal Arts Building, or on the throngs that swarmed in the plaza, tingeing everything they touched with the prismatic hues of the rainbow arch or the lambent whiteness of an alpine snow. Then at a word the lights vanished, and out of the darkness, with the suddenness of a geyser, the great electric fountains lifted their gushing and gleaming waters. Now a single column, surrounded at its foot by a score of

> golden sheaves, rose to a height of a hundred feet ; now nearly two thousand jets built up a great cone of limpid light, golden, blue, green, red, or of contrasted or mingled hues. There were two of these fountains, one on either side of the MacMonnies fountain, and through all their many changes each was the counterpart of the other, alike in colour and in form. When the fountains ceased playing, again the golden lines of electric lights flashed from dome and pediment, cornice and water line, and the giants fenced with search-light broadswords in the upper air (R. Johnson, 1897 p.481).

The above description partly encapsulated the essence of the World's Colombian Exposition for the nearly 26 million people that visited it. However, a more appropriate explanation was offered by Charles Mulford Robinson, when he described the fair as a spectacle, where the visitor would stroll and dream, both in the day and at night (R. Johnson, 1897).

4.15 Paris' *Exposition Universelle*, 1900

If the architectural style of the World's Colombian Exposition was overwhelmingly neoclassical, then in 1900, the style of the 5th *Exposition Universelle* in Paris was undoubtedly Art Nouveau. Once again, like the Expositions of 1878 and 1889, the main venue for 1900 Exposition was the *Champ de Mars* and extended across the Seine and upward to the *Palais du Trocadéro*. Additionally, like the 1889 Exposition, the 1900 *Exposition Universelle* stretched eastward along the *Quai d'Orsay*, this portion included *La Rue des Nations* (Avenue of the Nations) and *Section des Armees de Terre et de Mer* (Terrestrial and Marine Forces). The eastward extension of the *Quai d'Orsay* was likewise mirrored on the north or right bank of the River Seine; this portion contained Horticulture, *Palais de la Ville de Paris* (City of Paris) and *Economie Sociale Congress* (Social Economic Congress). Both of these extensions along the banks of the Seine were terminated by the *Esplanade des Invalides,* which itself extended northward across the Seine via the *Pont Alexander III* bridge. Once across the bridge, the Exposition grounds then contained a series of Art buildings, namely the *Petit Palais* (Small Building) and *Grand Palais* (Large Building), which were bounded by the grand entrances of the *Porte Monumentale* (Monumental Entrance) and *Porte Nicolas II*. On the main exhibition ground of the *Champ de Mars*, a large U-shaped exhibition structure was again used. The southern base of the ‘U’ was formed by the buildings for food and agriculture, centred on the large *Salle des Fêtes* (Hall of Festivities). The electrical building was positioned immediately to the north of the *Salle des Fêtes.* Additionally, the eastern arm of the ‘U’ comprised the buildings for mines, metallurgy, fabrics, clothing and machines, while the western arm of the ‘U’ comprised the building for chemicals, civil engineering, transport, sciences and education. Centred on the Eiffel Tower, the area immediately north of the large U-shaped structures was occupied by a number of smaller exhibition pavilions (Picard, 1902c, 1902d).

Figure 119 The *Chateau d’eau* at the *Exposition Universelle,* Paris, 1900 (Picard, 1902e)

A large *Chateau d’eau* (Water palace) was constructed to complete the main north/south axis that ran down the hill from the *Palais du Trocadéro,* across the *Pont d’léna* and under the Eiffel Tower (Figure 119). Located on the northern façade of the electricity building, the *Chateau d’eau* was essentially a large fountain that was set back into a large, curved ornate niche, with a grotto positioned below. Water falling from the fountain would cascade into a number of successively lower basins and finally into a large pool at it base. The entire length of the cascade was 125 metres and the total fall was 12.5 metres, while the primary materials were masonry and reinforced concrete. The main fountain at the head of the cascade was placed on an upper terrace that led both into the electricity building and downward to the lower terrace of the fountain; a staircase located below the fountain in a grotto joined the lower and upper terraces. Visitors traversing this inner staircase could pause and experience views of the exhibition grounds through a sheet of falling water from the fountain above. The entire cascade was artificially lit with electric lighting. The electrical control equipment for this lighting was located in rooms below the upper terrace (Picard, 1902e). At night, the fountains and water would create a scene of "…polychrome illumination…" (Fullerton & Olsson, 2004 p.269).

Figure 120 The *Salle des Glaces ou salle des Illusions* at the 5th *Exposition Universelle,* Paris (Images: Picard, 1902e).

A further larger façade was constructed and placed behind the main façade of the *Chateau d'eau*. A statue representing the *le Triomphe de l'Electricité* (Triumph of Electricity) in the form of a woman, or Fairy of Electricity, that rode a chariot pulled by *Pegasus* and a dragon and adorned with the date 1900, was placed at the apex of this secondary façade. Placed behind the statue was a 12-metre-diameter star that was lit with hundreds of shining lights. At its highest point, *le Triomphe de l'Electricité* was 71 metres above the ground. The statue of the Fairy of Electricity was constructed of zinc and embossed with opalescent glass mosaics. During the day, the statue glittered like a lacework of glass and steel in the sunlight, while at night it created the fiery impression of changeable lighting effects. Thus, the illumination of the *le Triomphe de l'Electricité*, in conjunction with thousands of additional coloured electric lights and powerful spotlights, created one of the central visual spectacles of the Exhibition (Picard, 1902e). Described as a fairy-land of light and beauty, the spectacle of the *Chateau d'eau* was reportedly "…beautiful beyond expression" (Addison & O'Grady, 1999 p.18). It needs to be acknowledged that the connection between the *Chateau d'eau* and Bruno Taut's *Glashaus* has already been provisionally exposed by Thiekotter (1993).

Located immediately behind the *Chateau d'eau* was the 410 metre long by 80 metre wide *Palais de l'Ėlectricité* (Palace of Electricity), which was so named not only for being a display area for electrical products, but also because it was the primary electrical generation facility for the entire Exhibition. A visit to the *Palais de l'Ėlectricité* could commence from the *Chateau d'eau*, thus continuing the main axis created by the *Palais du Trocadéro, Pont d'léna* and Eiffel Tower. Once in the *Palais de l'Ėlectricité,* this main axis was then further extended southward through the hexagonal-shaped *Salle des Glaces ou salle des Illusions* (Halls of Mirrors and Illusions) and onward to its final termination in the *Salles des Fêtes.* Additionally, the *Palais de l'Ėlectricité* was constructed with an iron frame that was in-filled with wood, glass and gypsum.

Based on a regular hexagon plan with six arched walls, the *Salle des Glaces ou salle des Illusions* had a domed roof modelled after the *Sala de las dos Hermanas* (Hall of the Two Sisters) at the Alhambra Palace in Grenada, Spain (Figure 120). At 21 metres high and with a maximum diameter of 26.5 metres, the *Salle des Glaces ou salle des Illusions* was however larger than the original *Sala de las dos Hermanas.* The underside of the dome was highly ornate with numerous copper-clad stalactites, geometric accent lines and star motifs. At the apex of the dome, a hexagonal opening was provided for ventilation. Lighting to the interior was achieved by numerous coloured electric lights. Six large chandeliers provided the main feature of the electric lighting system, which were connected together with strings of white electric lights. The chandeliers themselves were made from stamped zinc forms and had a 12-pointed star suspended from their bases. Approximately 3,000 electric lights, in red, yellow, white and green were placed throughout the interior of the *Salle des Glaces ou salle des Illusions*, and its six arched walls were decorated with mirrors. The use of these mirrors, in conjunction with the hexagonal shaped plan and the electric lighting, thus created a kaleidoscopic effect. Each element of the electrical design was further converted into an electrical network that could be independently switched on or off, the control of which was facilitated through a control room placed on a mezzanine level, 2.5 metres below the *Salle des Glaces ou salle des Illusions.*

Figure 121 The *Palais Lumineux* at the 5th *Exposition Universelle,* Paris (Image: Picard, 1902e).

A maximum of 1,000 people could be accommodated in the *Salle des Glaces ou salle des Illusions* at any one time. Admission was free of charge. Once the required number of visitors had entered the chamber, the access doors were closed and the curtains were drawn. After an electric bell had sounded, a series of bright flashing effects illuminated the chandeliers, stars, arches, and mirrors, reaching a crescendo when all the lights were turned on simultaneously, an event the ultimately led to applause from the astounded audience. Entry and exit to the chamber was via a series of staircases that led to a number of openings positioned in the mirrored archways. In excess of 20,000 people experienced the *Salle des Glaces ou salle des Illusions* per day. Special visits to the chamber were also facilitated for dignitaries, such as the French President. These were elaborate events with multi-coloured, model butterflies and dragonflies with glittering gossamer wings being displayed in a glittering atmosphere of rain created by fragments of mica. Additional illumination to these special events entailed the opening of a 1.2 metre octagonal hole to the mezzanine below, in which directional lights were installed (Picard, 1902e). Alternatively, the effect of the dome in the *Salle des Glaces ou salle des Illusions*, with its colour, zinc, and glass, was described

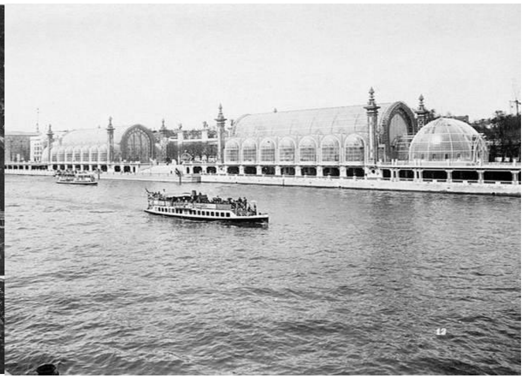


Figure 122 Left – The interior of the *Salle des Fêtes*, Paris, 1900 (Image: www.exposition-universelle-paris-1900.com).
Figure 123 Right – The *Palais de l'Horticulture* on the right bank of the Seine, Paris, 1900 (Picard, 1902e).

as "…metallic lacework…" that created a "…extravagant sumptuous factory rather than an exhibition palace" (Wailly, 1900 p.51). Another visitor to the *Salle des Glaces ou salle des Illusions* described the light show as having resembled a fairy-tale hall from a *Thousand and One Nights*; initially the show started with a bright display of sparkling golden lights and chandeliers, revealing the six-sided kaleidoscopic effect of the mirrors. The lighting then changed to deeper and darker colours, which revealed fluorescing marble columns and a multitude of graceful arabesques from rubies, emeralds, sapphires, gleaming silver pearls. Again and again the picture changed, and the crowd thus cheered loud and roared excitedly (Sauvage, 1900).

Also constructed at *Exposition Universelle* of 1900 was the remarkable *Palais Lumineux* (Luminous Palace). This structure was located on the main exhibition grounds, just to the east of the Eiffel Tower (Figure 121). Described as one of the greatest works of stained glass, glassware and mirrors ever created, the *Palais Lumineux* was designed by Ponsin. The flamboyant Rococo-styled *Palais Lumineux* was built entirely of glass, with a supporting structure made from metal. Located on a 196-square-metre site, the pavilion was constructed on a gigantic granite base, from which a 12-metre-high waterfall emanated. To reach the *Palais Lumineux,* two internally lit, glass staircases were provided, the sides of which were adorned with motifs of marine shells. The main façade to the *Palais Lumineux* took the appearance of a large portico, with high, twisted columns that had golden capitals. The rear façade had the wide portico replaced with a coloured glass rotunda that was constructed from glass blocks. Above the twisted and tormented roof, a statue of an 'Indian' that held a glittering golden globe, was placed. The interior vault was made in a veil of opal yellow, artistically decorated with translucent enamels, while the exterior consisted of a terrace with twisted columns and a roof finished in bright tiles. The interior floor of the pavilion was covered by a transparent shimmering 'carpet', while the curtains that covered the arched doorways were made from cut beads and adored with sun motifs. Below the pavilion, an underground cave was constructed, adorned with glass stalactites and that housed a number of glassblowers. Thousands of incandescent electric lights were mostly hidden between the glazing of the pavilion's structure and decoration, illuminating the building, giving it a magical appearance. The impression of a mysterious and wonderful spectacle was created for the visitor (Picard, 1902a).

The *Palais Lumineux* was described as having been 110 feet high and 175 feet in circumference and that it was made from glass blocks and sheets cemented together, the stained-glass panels having been made by J.A. Ponsin (Lee, 1901). Ponsin died before the work on the *Palais Lumineux* was complete, and the construction was therefore completed by a collective that comprised the architect M. Latapy, the Saint Gobain Company and Legras and Company of Saint-Denis (Picard, 1902a). Of further importance is the fact that the glass bricks that formed part of the rotunda to the rear of the *Palais Lumineux* were hexagonal in shape and looked remarkably similar to Falconnier blown glass bricks, as illustrated in Tissandier (1893). Falconnier's glass bricks were also mentioned as an award winner at the Paris *Exposition Universelle* of 1900 (www.glassian.org). Therefore, considering that Falconnier's glass bricks were blown, and that glassblowing was demonstrated in the cave below *Palais Lumineux*, it could be that Falconnier blown glass bricks were used in the *Palais Lumineux.*

At the southern end of the *Champs de Mars*, a large festival hall, or *Salle des Fêtes*, terminated the main axis. The *Salle des Fêtes* had a large monumental glazed dome above its central amphitheatre, which was 42 metres high (Figure 122). The dome itself was supported on 16 pillars and was constructed of in three sectional portions: the lower portion of the dome comprised the arched entrances; the second or intermediate portion was partly glazed and mostly intended for the escape of stale hot air, while the upper portion comprised a fully glazed, illuminated canopy that was 40 metres in diameter. While the lower two sections of the dome were decorated in an eclectic mix of neoclassical and baroque styles, the glazed dome was finished in leaded stained glass. Essentially a large solar arrangement, the stained glass had a central 'sun' motif, coloured yellow, purple and red, with numerous radiating rays in orange, green and yellow. Large swathes of dark blue, intermingled with star motifs, surrounded the central 'sun' figure. Eight female figures, throwing stars and comets, completed the composition. Thus, shadow and light mixed with the stained glass and created a nebulous and unpredictable lighting effect (Picard, 1902e).

In addition to the *Palais Lumineux*, *Chateau d'eau* and the *Salle des Glaces ou salle des Illusions*, numerous other 'traditional' domes were also present at the Paris Exposition of 1900. Designed by the architect A. Gautier, the *Palais de l'Horticulture* (Horticulture Building) was located on the right bank of the Seine, between the *Pont des Invalides* and *Pont de l'Alama* bridges (Figure 123). The *Palais de l'Horticulture* consisted of a pair of identical, arch-shaped, iron-framed glasshouses, measuring 60 metres long by 33 metres wide. Each large glasshouse additionally had seven smaller nave projections on either side. Additionally, the large glasshouse was connected to a smaller elliptical, dome-shaped glasshouse that was 17 metres long when measured parallel to the Seine, and 24 metres wide when measured perpendicular to the Seine (Picard, 1902b). Likewise, large glazed domes, with exposed iron structures were also located above the central portions of the *Grand Palais des Beaux-Arts* and the *Petit Palais du Retrospective D'Art*.

Embodied in structures like Renè Binet's grand entrance portico, or *La Porte Monumentale, t*he new artistic plastic yearnings of the Art Nouveau were one of the greatest architectural contributions of the 5th *Exposition Universelle* in Paris. However, within a larger context, possibly the greatest offering of the Exposition of 1900 was a seminal shift away from the serious exhibition of goods towards a more theatrical event that was full spectacle and illusion. But the 1900 *Exposition*

Universelle also marked an additional turning point for the 47 million people who visited it, in that the Western world, on the cusp of the 20th century, was "…growing older…"; and the advent of modern technologies like telecommunications and transport "…had the disadvantage of rubbing the novelty off many things" (Walton, 1902 p.85). The inevitable result of this disappearance of the feeling of novelty was for the Paris Exposition of 1900 to have provided the visitor with an alternative and mostly emotional experience.

4.16 Conclusion

As stated earlier, the *Glashaus* was a round pavilion building with a structurally expressive dome. In section, the building consisted of two distinct portions: a round, upper glazed portion that contained the dome, staircases and the Dome or Cupola Room. And, below this light-filled upper portion, the Cascade Room and kaleidoscope were housed in a darkly lit elongated form that comprised the second portion. In addition to staircases, an oculus positioned in the centre of the Cupola Room's floor connected the upper and lower portions of the *Glashaus*.

A simple comparison between the *Glashaus* and the multitude of exemplars listed above reveals immediate similarities. The *Glashaus'* dome and supporting structure could be argued as having strong precedents in buildings like that of New York's 'Crystal Palace' of 1853, London's Exhibition Palace of 1862, the *Rotunde* of Vienna in 1873, and the numerous examples of the Paris Exhibitions of 1878 and 1889. Likewise, the fountain and cascade present in the *Glashaus* had numerous precedents, such as the water features on the grounds of the Crystal Palace in Sydenham; the Hydraulic Basin at Philadelphia's Centennial Exhibition of 1876; the *Palais du Trocadéro* with its extensive system of waterfalls, cascades and ponds that descended down the Chaillot Hill, which were a defining feature of the Paris Expositions of 1878, 1889 and 1900; and the extensive canal, basin and fountains of Chicago in 1893.

However, it was the World's Expositions of 1893 in Chicago and Paris in 1900 that were the most influential on the design of the *Glashaus*. From Chicago's 1893 World's Colombian Exposition, the Horticulture Hall with its central dome below which sat the miniature tropical mountain with its Crystal Cave, offer an astoundingly similar conceptual arrangement to the *Glashaus*. Likewise, the Moorish Palace with its ‘Magic Maze’, ‘bottomless well’ and glittering cave, also offered immediate conceptual similarities with the *Glashaus*. Additionally, the primary building material of the *Glashaus*, i.e. the simple pressed-glass tiles, could also have had their origins at the 1893 Exposition. As Neumann (1995a) has mentioned above, it was possible that Crew and Basquin, and not Pennycuick*,* invented prismatic glass and supposedly exhibited their invention at the 1893 World’s Colombian Exposition. In addition to prismatic glass, Falconnier-blown glass bricks were also on display at the Exposition of 1893. The *Glashaus* too had numerous affinities with the new technology of electricity that was to be found in abundance in Chicago, particularly evident in the in the displays of companies like the Edison Electric Company and the Phoenix Glass Works Electric Tower.

The Paris Exposition of 1900 also had architectural examples that had direct and immediate relevance to the *Glashaus*. The *Chateau d’eau* with its large fountain that was set back into a large curved ornate niche and grotto below can be argued as related to the *Glashaus*. Likewise, the *Salle des Glaces ou salle des Illusions* – with its regular hexagon plan and arched walls, wondrous’ metallic lacework’ Moorish domed roof, numerous coloured electrical lighting effects and chandeliers, octagonal oculus, and staircases – could be proposed as an uncannily similar precursor to the *Glashaus*. Nevertheless, the building that best mirrored the later *Glashaus* was the *Palais Lumineux.* Here, all of the principal ingredients of the *Glashaus* were evident: distinct upper and lower portions; glazing in a myriad of forms; staircases; and a fountain. However, just as Neumann (1995a) had contended, the *Palais Lumineux* additionally, and more importantly, owed much of its effect to the particular details of the glazed products used.

A further integral constituent of the *Glashaus* was its mechanical kaleidoscope. Supplied by the firm *Eduard Liesegang Fabrik Optischer Apparate* (Eduard Liesegang Factory for Optical Instruments) in Düsseldorf, the kaleidoscope was housed at the base of the cascade, in a 2.5-metre-deep room in the basement of the *Glashaus*. Powered by an electric motor, the kaleidoscope projected rotating images onto a frosted glass screen. The images themselves were created by numerous artists, including Franz Mutzenbecher from Berlin and Adolf Holzel from

Stuttgart (Ahlstrand, 1993). As seen in the argument above, kaleidoscopic installations and result effects were a feature of Exposition architecture in the 19th century. The first was the 'gigantic kaleidoscope' in the Moorish Palace at the Chicago World's Exposition of 1893, following the earlier development *Castan's Irrgarten* and Gustav Castan's Patent of 1888. Thus, Taut's use of a kaleidoscope, albeit in a different form, can be argued as the continuation of an already existing tradition.

As stated above, the *Glashaus* had two distinct portions; namely an upper structurally expressive round dome and a lower elongated form that contained the fountain and cascade. Considering that in the argument above, most of the domes mentioned were glazed, structurally expressive and were a central defining feature of their parent buildings. Furthermore, the cascades and water features listed were mostly tiered, longer, linear elements. It is therefore clear that both the *Glashaus'* dome and its fountain and cascade were an evolution of well-established precedents, albeit it as a smaller example. It is therefore highly likely that the two distinct portions of the *Glashaus*, in particular their form and aesthetics, evolved directly from these earlier precedents. Likewise, the *Glashaus* also had numerous affinities with the Expositions of 1893 and 1900; in particular, the *Chateau d'eau*, the *Salle des Glaces ou salle des Illusions* and the *Palais Lumineux.* However, unlike the earlier affinities that were more about aesthetics and form, these later similarities were more importantly about character, effect and spectacle.

Therefore, if we consider the *Glashaus,* it would appear to be a continuation of already existing practices and precedents. This would indicate that the person/s involved were acutely aware of these earlier precedents. Additionally, it would seem that they were actively seeking to amalgamate the best features of grand exhibition architecture in the *Glashaus*. But the question would then be who exactly this was.

Frederick Keppler arrived in Southampton on 10 January 1898, and 13 months later he took up residence in Berlin (Keppler, 1899a, 1904). Where was Keppler for these 13 months, between January 1898 and February 1899? To answer this question, some preliminary contextual facts first need to be considered. The first of these facts is that Keppler was first in Britain, and then later made his way to

Germany. The second fact is fact is that Keppler was a man of diverse talents: architect, builder, entrepreneur and employee of the Luxfer Prism Company. Third, Keppler, in all probability, departed for Europe to commence his employment with the *Deutsche Luxfer Prismen Syndikat.* Given this, it is thus highly likely that Keppler was fully aware of Luxfer products and the associate work of Henry Crew and his assistant Olin H. Basquin. Therefore, it is also likely that Keppler was aware of Crew and Basquin's 1898 publication, the *Pocket Hand-Book of Use of Electro-Glazed Luxfer Prisms.* Keppler would have known of Crew and Basquin's desire to create new luxurous and crystaline lighting effects though the use of Iridian Luxfer Prisms. Therefore, considering that Keppler was primarily in Europe to both expand the presence and market penetration of Luxfer products, it could well be that his later 'simplified' glass tiles were nothing but a further iteration of Luxfer's Iridian Prisms.

Furthermore, Keppler was in Europe to to seek out new buisness opportunities. It would be logical to assume that he would have wanted to make contact with established European manufacturers, view their product range and establish how they marketed their products. Thus, it would be logical to assume that during the 13 months before he took up residence in Berlin, Keppler was doing just that. However, there is also the possability that Keppler was doing this well before he even departed for Europe. Considering that Keppler was most likely a resident of Chicago in 1893, can it be assumed that he would have visited Chicago's 1893 World's Colombian Exposition? In all probability he did, and for the sake of this dissertation, it will be accepted that he did. Thus, it would be feasible to assume that while visiting the 1893 Exposition, Keppler had exposure to the Moorish Palace, the Libby Glass Company's pavilion, the captive balloon, the Horticulture Building and its Crystal Cave, the glasshouses that included those of Falconnier, the pavilion of the Tiffany Glass and Decorating Company, and the Edison Electric Company and the Phoenix Glass Works Electric Tower. Similarly, when Keppler is in Britain, would he not have visited seminal glass structures like the Sydenham Crystal Palace? This is clearly feasible considering that the Crystal Palace was destroyed by fire much later in 1936 (Chadwick, 1961). Likewise, the Water Temples were only demolished in 1904 (www.sydenham.org.uk, 2006). Therefore, could Keppler have seen the Crystal Fountain and the Water Temples? After Britain and later while on continental Europe, would Keppler not at the very least been aware of the wonders of the *Exposition Universelle* of 1900? Thus, would Keppler have been conscious of the *Chateau d'eau*, the *Palais de l'Ėlectricité* with its *Salle des Glaces ou salle des Illusions*, *Palais Lumineux*, and all the other electrical and fantastic attractions of the 1900 Exposition?

The fundamental fact remains that Keppler's brief was to introduce the products of the Luxfer Company to European consumers. Furthermore, there was a longstanding tradition of both American and European glass manufacturers exhibiting their products at trade fairs and public exhibitions. Neumann (1995a) has also argued that Luxfer's European branches also frequently participated in trade fairs and exhibitions, and actively sought the attention of architects. Moreover, he has indicated that the pavilions they used formed a distinct prototype, with domes, staircases, fountains, and a specific character composed through its use of glass. As evidenced from the descriptions above, domes, staircases, fountains, structural expression and glass 'character' were all prominent elements that had been previously used in Exposition architecture. Additionally, it is clear that the distinct prototype of the Luxfer Company, in all probability, evolved directly from prior exemplars of Exhibition architecture. Considering Keppler's experiences and business aspirations, it is proposed that he was a key figure in formulating the prototype for Luxfer. It is further proposed that Keppler would have briefed Taut on the generic requirements for the *Glashaus* of 1914. Thus, this hypothetical brief could have included the requirement for a 'stand-alone' pavilion building that had a glazed dome; that the pavilion use Luxfer products as the main building product; that the pavilion showcase Luxfer products in the best possible manner; that the building should have two distinct portions, i.e. an upper glazed, brightly lit portion, and lower, darkly lit portion; that the pavilion contain interesting electric lighting; that the electric lighting showcase the building at night; that the structure to the dome should be structurally expressive; and that the building should contain staircases, a fountain and a cascade.

From the above argument, it is clear that the *Glashaus* followed an established prototype. The larger implication is that the *Glashaus* was far from being *"...*captivating in its individuality and completeness... "(Jensen, 1915 p.25);

rather, it was forcefully prescribed and controlled. Even Jensen (1915) acknowledged that Taut's *Glashaus* made him think of a prior French glasshouse in Paris during 1900; this 'artistically worthless precedent' was however insignificant when compared to the small jewel that was the *Glashaus*. Could this have been both a direct acknowledgement of a connection to the *Palais Lumineux*, and more importantly, an acknowledgement of the importance of precedent and the continuation of tradition?

The most commonly acknowledged perspective on the *Glashaus* proposes the building as a fanciful, utopian phenomenon; however, this is fabricated, Expressionist propaganda. What the argument above has established is another distinct theory that explains the building from the perspective of the client. When the *Glashaus* is viewed from this perspective, it becomes something very different. Therefore, the *Glashaus* can be proposed as a building whose planning, form and materials closely resemble earlier precedents; and that is the result of an intentional, prescribed formula that best showcased the commercial interests of the client.

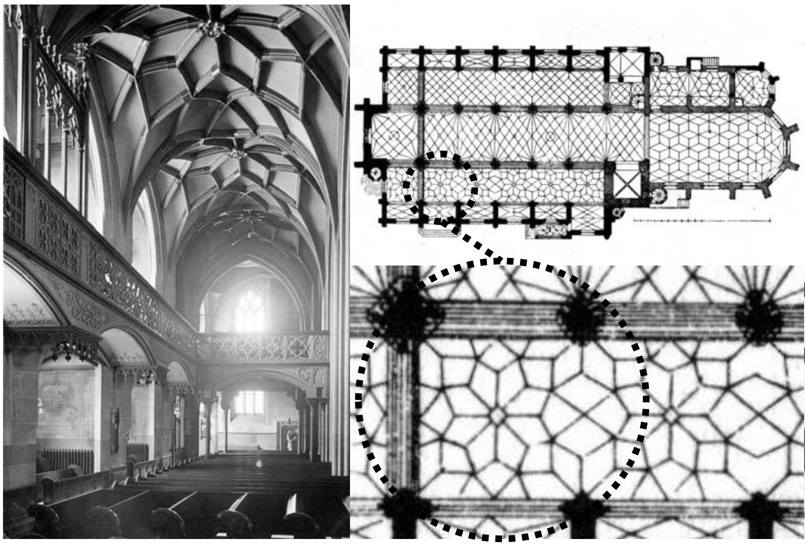
Here, it is worth recalling "Die Galoschen des Glucks", in which Taut (1920b) made direct reference to the 'man' that led him into the wondrous chamber, in which sparkling houses grew from the leaves and strange growths. It is thus proposed that this 'man' could have been Frederick Keppler. However, like the previous chapter on the *Victoria regia*, this is only a partial explanation; the 'man' could also be somebody else, a number of people, or even a metaphor for something else. This aspect will be explored in the next chapter.

Chapter 5: Imitating the Gothic

5.1 Introduction

In this chapter, it will be argued that the 'man' from "Die Galoschen des Glucks" is possibly not a person, but is instead a metaphor for the Gothic. This proposition is reasonable because almost all references to Taut and the *Glashaus* contain some fragment of the Gothic.

Gutschow (2005) noted how Taut long professed the need to consider continuing traditions and established archetypes when designing, and the Gothic was the traditional archetype often evident in the wider context of Taut and the *Glashaus*. Paul Scheerbart (1914) mentioned the Gothic in *Glasarchitektur*, and Taut



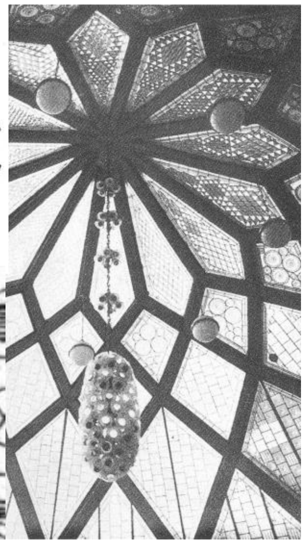


Figure 124 Left – Interior of Stuttgart's *Stiftskirche* showing the south aisle with its original vaulting. Centre – Plan of Stuttgart's *Stiftskirche* with an enlarged portion showing the layout of the rib vaulting above the south aisle (Image: www.commons.wikimedia.org).
Figure 125 Right - An interior image of the *Glashaus'* dome. The aesthetic and structural arrangement is remarkably similar to that of Stuttgart's *Stiftskirche* (Images: Centre - Dehio & von Bezold, 1901; Left - www.stiftskirche.de).

quoted from *Glasarchitektur* when he wrote his 1914 pamphlet "Glashaus: Werkbund-Ausstellung Köln 1914, Führer zur Eröffnung des Glashauses" ("Glashaus: Werkbund Exhibition in Cologne 1914, A Guide to the opening of the Glasshouse"). Here, Taut quoted Scheerbart in stating that Gothic architecture was the prelude to their new glazed architecture. Behne (1912) wrote his dissertation on Tuscan Gothic church ornamentation and further published "Die Gotische Kathedrale" in 1914.

Taut himself wrote about the Gothic in his 1904 article “Natur und Baukunst” and again in his later 1914 article “Eine Notwendigkeit”. Taut also made specific references to particular examples of Gothic architecture, namely Strasbourg Cathedral, in both his 1919 article “Ex Orient Lux: Aufruf an die Architekten” and in a letter he wrote to the Crystal Chain group on 28 January 1920. In “Ex Orient Lux”, Taut praised Strasbourg Cathedral as having been comparable to the wonders of the Orient, while in the 1920 letter, Taut explained his ecstasy when climbing the Cathedral’s bell-tower.

> Tonight I went up the tower of the Strasbourg Minster, through all kinds of scenery, cried with delight, and came to a wood, where houses grew on the trees instead of leaves (Whyte & Taut, 1985 p.46).

In *Architekturlehre: Grundlagen, Theorie und Kritik aus der Sicht eines sozialistischen Architekten (Teaching Architecture: Foundations, Theory and Criticism from the perspective of Socialist Architects)*, Taut published an image of the western façade of Strasbourg Cathedral (Taut, 1977). In a similar vein, Taut, in his 1904 article “Natur und Kunst” (“Nature and Art”), also illustrated the central nave of Stuttgart’s Gothic *Stiftskirche* (Collegiate Church).

If Strasbourg’s Cathedral and Stuttgart’s *Stiftskirche* are compared to the *Glashaus*, numerous similarities are immediately apparent. The original vaulting above the south aisle to Stuttgart’s *Stiftskirche* was composed of a number of rhombic-shaped facets that, when viewed in plan, assumed a star-like arrangement (Figure 124). Unfortunately, this original vaulting was destroyed in World War Two during the allied bombing raids on Stuttgart. Nevertheless, it was still accessible to Taut in 1904. When the aesthetic of the *Stiftskirche*’s original vaulting is compared to that of the structure of the *Glashaus’* dome, they appear as remarkably similar, if not identical (Figure 125). As extensively argued earlier, one of the most impressive features of Strasbourg Cathedral is its western rose window (Figure 17), and a comparison between it and the dome of the *Glashaus* reveals astonishing similarities. For example, they use the same colours, were centrically planned, and had elaborate structures.

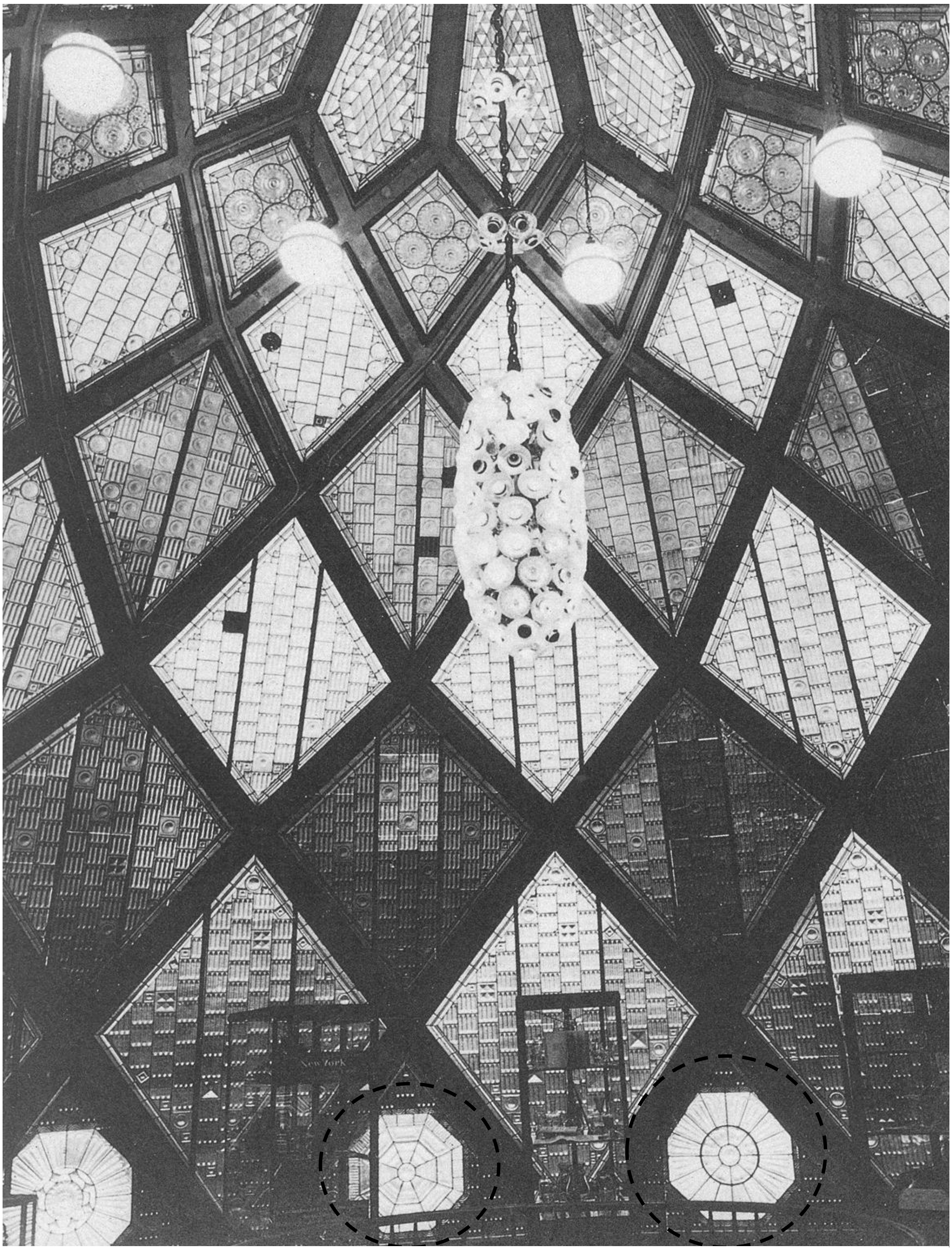


Figure 126 The 14 octagonal figures that were present at the base of the *Glashaus* dome's glazed skin – indicated by dashed lines (Image: Thiekotter, 1993).

While this direct connection to Gothic exemplars might simplistically answer the question concerning the origins of the *Glashaus*, it still does not fully address the issue. Therefore, significant questions are still unanswered. Why would Taut be interested in the Gothic, and why specifically Strasbourg Cathedral and Stuttgart's *Stiftskirche*? More importantly, what does the Gothic, Strasbourg and the

Stiftskirche contribute to the discovery of alternative motives and inspirations behind the design of the *Glashaus*?

5.2 *Gotik und Deutsch* (Gothic and German)

In the 19th century, the Gothic cathedral and the medieval conception of society were perceived as symbols of political and national identities, collective memories, traditions and histories. As such, whichever nation could claim the Gothic as its own invention could firmly define its own national identity and gain prominence over others that were likewise attempting to do so. During the Napoleonic period (1799–1815), both the Germans and British saw the Gothic as their own national creation, while the French perceived it as a German creation (Glaser, 2002). In 1772, Johann von Goethe wrote "Von Deutsche Baukunst" in which he claimed that the Gothic, in the form of Strasbourg Cathedral, was German architecture. In the opening paragraph of this book, Goethe elaborated on his search for a memorial to the designer of Strasbourg Cathedral, Erwin von Steinbach. After searching in vain, Goethe concluded that von Steinbach did not need a memorial, since the magnificent colossus of the Cathedral, "…like trees of God" was more than sufficient (von Goethe, 1772 p.2). Goethe then argued that Greek classicism as inherited by the Italians, and as later employed by the French—with its rules of proportions, stark ornament, and use of associated classical columns—were not at all appropriate to the northern European context. Instead, Goethe proposed that they should rather build like von Steinbach by devising an architecture that was rooted in the context of place, people and culture:

> Diversify the enormous walls, you should so build towards heaven that they rise like a sublimely towering, wide-spreading tree of God which, with its thousand branches, millions of twigs and leaves more numerous than the sands of the sea, proclaims to the surrounding country the glory of its master, the Lord (von Goethe, 1772 p.4).

Goethe (1772) then admitted that when he first experienced Strasbourg Cathedral, he was initially influenced by his prior classicism-instilled preconceptions of what constituted appropriate architecture. He referred to the building as having been overpowered with applied effects and overloaded with ornament, with a shambolic, crude and unnatural aesthetic. However, these initial perceptions were only fleeting. Goethe then described his surprise at the harmonious experience, dignity and magnificence of Strasbourg Cathedral as one that he was not fully able to explain or identify. He proposed Strasbourg Cathedral as a holistic and soulful experience that embraced the enormous spirit of his 'medieval bothers'. Furthermore, Goethe referred to the 'secret powers' of the Cathedral's towers and the sparkling of the building in the early dawn mist. He continued to describe Strasbourg Cathedral by praising its harmonious masses that were alive with limitless detail, and that mirrored the magnificent work of nature where all things were perfectly formed. Goethe then, with religious zeal, proclaimed: "…thank God… …that this is German architecture, our architecture" (von Goethe, 1772 p.6). Goethe continued by stating that the only true art was one that became active in people through internal, united, exacting and autonomous emotions, thus creating beauty from within the individual mind. He then stated that the most appropriate source of inspiration for these independent emotions and resultant beauty was to be found in nature, and that youth were best equipped to express the resultant forms (von Goethe, 1772).

In "Von Deutsche Baukunst", Goethe was dismissive of other European nations, particularly the French. Undoubtedly, this attitude can be contextualised with the then German search for a unified national identity, and the formative desire of the German peoples to become free of French political control and cultural dominance. Likewise, his thinking also contained associations with German Romanticism—seeking a synthesis of art, literature and science, while similarly looking to the Middle Ages for inspiration on a harmonious and unified society.

The next author to develop Goethe's notions of the Gothic as German was Karl Wilhelm Friedrich Schlegel (Glaser, 2005). In 1806, Schlegel published his *Briefe auf einer Reise durch die Niederlande, Rheingegenden, die Schweiz, und einen Theil von Frankreich* (*Letters from a Tour of the Netherlands, Rhine Regions, Switzerland and Parts of France*). According to Glaser (2005) this work was a nationalistic text. Like Goethe (1772), Schlegel (1806) proposed that Gothic was German because of its connection to the customs, climate and nature of northern Nordic Europe. It is important to note at this point that the concept of 'German' is identical to the term 'Nordic' that is commonly used in both early texts, like Goethe and Schlegel, and later texts. For Schlegel (1806) it was the artistic awareness (*Kunstsinn*) and the artistic commitment (*Kunstfleiss*) of the German people that had created the Gothic through their love of nature and daring imagination. However, unlike Goethe (1772), Schlegel (1806) proposed the unfinished edifice of Cologne Cathedral as the ultimate personification of this Germanic Gothic. Schlegel (1806) even went so far as to dismiss Strasbourg Cathedral as late and decadent Gothic. According to Glaser (2005), this dismissal of Strasbourg Cathedral was, in all probability, a form of misguided patriotism and a protest against French foreign domination, as Strasbourg was then a French city.

At about the same time as Schlegel's (1806) publication, a close friend of Goethe's, Karl Friedrich Schinkel, also had the opportunity to visit Strasbourg Cathedral. In *Reisen nach Italien (Travels to Italy)*, Schinkel like Taut one hundred years later, climbed the tower of the Strasbourg Cathedral (Schinkel & Riemann, 1979). He detailed this 20 July 1824, visit to the Cathedral as follows: Describing his approach to the Cathedral, Schinkel (1979) told of the 'glorious building' that towered over the medieval city with its transparent, skeleton-like spire. He then detailed how, as his vehicle stopped at the entrance portal to the Cathedral, the enormous mass of the building seemed to rise before him in a bolder and more accomplished manner than that of Cologne Cathedral. Schinkel (1979) then detailed the red sandstone from which Strasbourg Cathedral was constructed, describing it as magnificent and blackened with golden moss, giving it the appearance of a bronze casting. Strangely, he described very little of the interior, other than a mere mention of its lighting being achieved through stained-glass windows. For Schinkel (1979), the delight of a visit to Strasbourg Cathedral, however, lay in climbing the open-work spire that was accessed via a spiral staircase. He ascended from the ground level and arrived at the 300-foot-high platform at the base of the open-work spire:

> Then we climbed the tower to the platform, where an unparalleled overview of Alsace, the Black Forest and the Vosges Mountains, and

> where you can see the finished tower quite close, a marvel of bold and beautiful design (Schinkel & Riemann, 1979 p.145).

Continuing to climb the ‘octagon’ of the open-work spire, Schinkel (1979) found to his surprise that the upper portions of the spire had no abutment. Furthermore, he described the uppermost tip of the spire as a beautiful and unifying mass of stone. The result for Schinkel was that both the ornament and structure effectively became one. For him, this holistic synthesis of form and function was unlike Cologne Cathedral, which he described as having been full of danger and lacking surety. Descending the spire, Schinkel then returned to the platform, which he then described as ‘magnificent exposed stone’ not only devoted to religious purposes but also to general entertainment. Conjuring up a vision of beautiful evening festivities, with dancing and festivities, Schinkel then described von Steinbach’s Strasbourg Cathedral as a true monument. He then departed this ‘wonderful place’ and descended once again via the spiral staircase to the Cathedral below (Schinkel & Riemann, 1979).

For Schinkel, Strasbourg Cathedral’s spire was not, however, the pinnacle of perfection. A day after his visit to Strasbourg Cathedral, Schinkel subsequently visited Freiburg Cathedral. He described the tip of the open-work spire in Freiburg as having the greatest value and beauty, being far more harmonious than the spire of Strasbourg. Like Strasbourg, the open-work spire of Freiburg Cathedral was also accessed via a narrow, spiral staircase. Likewise, Freiburg’s spire was described as a hollow, tapered and transparent structure that also started on a square plan and then approximately midway transformed into an octagonal plan, and as it ascended upward, slowly dematerialised before reaching the tip (Schinkel & Riemann, 1979). Freiburg Cathedral was superior because it used far fewer resources during construction. Schinkel then detailed an evening walk to the heights overlooking Freiburg. As with the earlier explanation above of Strasbourg Cathedral within its wider urban context, Freiburg Cathedral was uplifted from the crowd of the medieval city. In the light of the late afternoon, with the sun hiding behind the main spire and with it rays shooting outward, the composition of the image was perfect, according to Schinkel (Schinkel & Riemann, 1979).

With the defeat of Napoleon in 1815 and the supposed removal of French domination, Germans subsequently modified their views of the Gothic. At the Congress of Vienna (1814–15), Europe was divided into a number of spheres of influence, namely, Britain, Prussia, Austria, France and Russia. The Congress, however, made the fundamental error of largely suppressing German nationalist aspirations. Rather, to the detriment of the emergent Prussia, the Congress assumed that the Austro-Hungarians were the dominant 'German' power. The result of the Congress of Vienna was the creation and maintenance of numerous smaller Germanic states. This essentially created a central European buffer between the powers of Russia, Austria and France. As such, political and economic rivalry between Prussia and Austria-Hungary dominated the Germanic landscape until German unification in 1871, with Prussia the eventual victor (James J Sheehan, 1989).

During this post-Napoleonic period, the Germanic perception of the Gothic evolved into a political symbol of an 'unfinished national project', which shifted focus away from Strasbourg Cathedral and toward the unfinished project of Cologne Cathedral (Glaser, 2005). Authors such as Josef von Görres (1814, 1842) declared Cologne Cathedral as a symbol of unfinished German nationalism, and one that personified German weakness. Von Görres (1814, 1842) therefore urged all Germans to rediscover the 'collective effort' of their medieval ancestors, so as to heal the rifts between Germanic peoples. According to Glaser (2005), von Görres proposed Cologne Cathedral as a symbol of societal transformation and its eventual completion as a further symbol of a strong and united Germany. When work did eventually commence on completing the Cathedral in 1842, the then Prussian king Friedrich Wilhelm IV, declared it to be a symbol of a secular and unified Germany (Nipperdey, 1981). According to Glaser (2005), by 1842, the Gothic as personified in Cologne Cathedral was therefore inextricably bound to German national memory and future unity. However, 1842 was a significant year because it was proven then that Cologne Cathedral was in fact modelled after Amiens Cathedral, essentially making it a French design, and a design of the ‘enemy’ (Glaser, 2005). Considering that the Gothic was at this stage indivisible from the German nation, the emphasis thus evolved into a stylistic argument. While this argument admitted that the French had invented the Gothic, it argued that the Germans had brought it to its highest perfection. Glaser (2005) cited Franz Theodor Kugler as having propagated this view during the 1840s, who, incidentally, published a monograph on Schinkel in 1842 (www.dictionaryofarthistorians.org).

In the 1840s, archaeological evidence had verified the origins of Gothic as being in Normandy. The French thus faced the difficulty of taking ownership of the Gothic after the end of the Napoleonic era. This was particularly problematic since, then, the French had conceded the Gothic as a German innovation. Initially, the French Revolution regarded the Gothic as a symbol of an oppressive feudal and ecclesiastical past (Glaser, 2005). Strasbourg Cathedral almost lost its spire during this time. The citizens of Strasbourg however crowned the spire with a giant Phrygian cap and thus associated the Cathedral with a group of revolutionaries, *Les Enragés* (The Enraged Ones), and the ideals of the Revolution (Kurtz, 2006). However, when revolutionary fervour had subsided, French perceptions of the Gothic increasingly saw it as symbolic of their national culture, customs, religion and traditions. Much like their German counterparts, the French Romantics in the early 19th century saw medieval Europe as a ‘golden age’ of heroism and gallantry, fervent Christian faith and unity of ecclesial and royal power. While the Germans saw the Gothic as a symbol of their fledgling national identity and a desire to rid themselves of domination. The French, under the rule of the Bourbons (1815–30) instead saw the Gothic as a part of a decorative style that was intended to revive ecclesial and royal power. With the overthrow of the Bourbons in 1830, the Gothic was again reinvented. However, this time it became a symbol of secular power, the product of the people, inspired by human imagination, and instilled with a spirit of democratic liberty (Glaser, 2005). This later view was personified in Victor Hugo’s (1831) publication *Notre-Dame de Paris, 1482*. Viollet-le-Duc (1875) later expanded Hugo’s argument by proposing the Gothic as the product of a nationalistic movement against feudalism. As such, for the French, the Gothic personified a struggle against ecclesial, royal and feudal power, while for the Germans it was a symbol of national identity and a longing to rid themselves of French domination (Glaser, 2005).

5.3 The Gothic and the British

The British, like the Germans, had seen the Gothic as a constituent of their national character during the Napoleonic period. However, the British had very early on ceded the origins of the Gothic to the French (Glaser, 2005). Undoubtedly, the British, like their German and French counterparts, saw the Gothic through the lens of Romantic conventions. The British version of Romanticism however had very little connection to nationalism; instead, it sought inspiration in exotic lands, culture and myth. Therefore, in the early 19th century, the British, as the single nation most influenced by the Industrial Revolution, sought refuge in the writing of Wordsworth, Shelley, Keats and Byron (Eastlake, 1872). Gothic Revival architecture can be proposed as the personification of British Romantic thought, with Augustus Welby Northmore Pugin perhaps being the pioneering proponent of the movement (R. Hill, 2007). In the early 19th century, Pugin and his father published five texts that presented examples of British Gothic Revival architecture. Of these five, *Specimens of Gothic Architecture* comprised the first two volumes, while the last three volumes were entitled *Examples of Gothic Architecture* (1825; 1825; 1838, 1839, 1840). In his later publication, *Contrasts*, Pugin additionally disseminated his thoughts concerning the Gothic ethos and presented the medieval age as one of a pure and unadulterated society when compared to the early 19th century. For Pugin, the society and state of the medieval period was good and therefore its architecture, i.e. Gothic, was also good (Pugin, 1836). Likewise in his subsequent publication, *The True Principles of Pointed or Christian Architecture,* Pugin (1841) resolutely prescribed the features and methods of Gothic Revival architecture: it should be honest in its appearance and the building's features should be essential to its proper functioning and construction. Likewise, the building's features and methods of construction should be honestly expressed and judged by the strictest standards of Catholic morality (Pugin, 1841). As a result, Pugin was undoubtedly influential on John Ruskin (Conner, 1978). According to William Morris, while Pugin presented the first wave of the Gothic Revival according to an ecclesiastical Catholic perspective, Ruskin, in a secular manner, later gave it life and spirit (LeMire, 1969). Interestingly, the first of Ruskin's articles was published in *The Magazine of Natural History*, which was edited by John Claudius Loudon, who commented to Ruskin's father in 1837 that John Ruskin was undoubtedly the greatest natural genius that he had ever met (Cook, 1911).

In 1849, Ruskin published *The Seven Lamps of Architecture* in which he presented seven 'Lamps', or principles, that all appropriate, or good, architecture should contain: 'Sacrifice' as a symbol of man's love and obedience to God, 'Truth' of construction and materials, 'Power' of architecture through the greatness of nature, 'Beauty' of architecture and ornamentation inspired by nature, 'Life' of the builders and freedom of expression, 'Memory' of culture and context, and 'Obedience' to history and tradition. Ruskin argued that most architecture since the Gothic, and in particular that of the Industrial Revolution, had lost its spirituality and affinity to nature. While Ruskin added nothing new to the debate concerning Gothic Revival, he did however skilfully encapsulate the atmosphere of the period (Curl, 2006). Also interesting is the contention that much of Ruskin's (1849) thinking derived from Archibald Alison's 1790 *Essays on the Nature and Principles of Taste* (Hersey, 1972). Starting in 1851, Ruskin elaborated on his earlier thoughts in *The Seven Lamps of Architecture* by publishing a three-volume set under the tile *The Stones of Venice*, in which he (1853) analysed architectural features and details in an effort to establish whether or not they complied with his earlier principles. In the second volume of *The Stones of Venice*, Ruskin (1853) published a number of chapters devoted to the Gothic, of which "The Nature of Gothic" is the most important to this research. Using the Gothic as both a metaphor and physical example, Ruskin proposed that it had six essential characteristics. These, listed in order of importance, were: 'Savageness', 'Changefulness', 'Naturalism', 'Grotesqueness', 'Rigidity', and 'Redundance' (Ruskin, 1853). I will discuss each of these in detail below.

The first and most important, Savageness or 'Rudeness' was more of a metaphor than physical example. Ruskin argued that, historically, the architecture, people and cultures of northern Europe were traditionally seen as barbaric, stern, contemptible, wild and rude. Continuing, Ruskin then stated that the Savageness of northern European architecture, i.e. the Gothic, was a direct result of the physical character, or context, of its place: its rugged, strong and noble people, its forests, its high, ice covered mountains, its shaggy and stout animals, its moss-covered rocks, sombre and moody weather, and grisly landscapes. Contrary to prevailing opinions, Ruskin argued that this Savageness of place, instead of being deplorable, was rather praiseworthy and dignified; it was these very characteristics of place that deserved a profound reverence. Savageness implied a "…look of mountain brotherhood between the cathedral and the Alp… magnificence of sturdy power" (Ruskin, 1853 p.157-8). He then argued that Gothic architecture's Savageness additionally derived from the higher characteristic of 'religious' principles that were instilled in Christian men. The men who constructed Roman architecture were mere slaves, with precise and inferior minds; by contrast, the men who constructed the Gothic were noble, imperfect and free-thinking men. In other words, the Gothic was constructed by men freed from sin by Christianity and instilled with independent minds and thoughts. These noble Gothic men, united in a collective endeavour, thus had pleasure in their work; work that, even if it was imperfect, intended to showcase the glory of God. As such, the Savageness of Gothic was also more importantly a mental attitude of a free and independent mind (Ruskin, 1853).

Ruskin started his definition of Changefulness or 'Variety' by stating that where the constituent parts of buildings were alike, then the workmen were undoubtedly utterly enslaved, i.e. they had no Savageness of thought. In contrast, Gothic architecture was designed and executed by workmen who were utterly free and consequently had Savageness of thought, and were capable of perceptual novelty. Changefulness implied that the Gothic broke the prevailing rules of form and rhythm that were established in classical architecture. Through this infringement of prevailing principles, the Gothic therefore created the novel and constantly varying variety of forms of the pointed arch, the grouped column, and tracery. It was thus the irregularity and rich variation of form that expressed the energy of the Gothic and Christian love of variety. However, Changefulness had to be managed, not just in design but also in effect. It was further proposed that if change was too often repeated, it would cease to cause delight; as such, change had to be mixed with a certain degree of monotony. Only having experienced, endured or suffered through monotony could the beholder then experience the ecstasy of change—a process that Ruskin termed 'transparent monotony' (Ruskin, 1853).

The third characteristic of Gothic architecture was Naturalism, or 'Love of Nature', which entailed the realistic and emotional representation of natural facts through design. Naturalism was not the interpretive representation of nature as presented by the ancient Romans; rather, it was an honest recreation that left no need for interpretation. Ruskin contended that the Naturalism that best manifest it true character of the Gothic was to be found in its fondness of representational veracity of vegetation. Not only did the Gothic workman faithfully represent foliage, but he also did it with intense affection and habitual tenderness, therefore being indicative of a more tranquil and gentle existence. Ruskin was careful to dismiss the prevailing notion that the Gothic derived from vegetation, namely "…from the symmetry of the avenues, and the interlacing of the branches" (Ruskin, 1853 p.201). Rather, he contended that the Gothic grew into a similarity with vegetation because of the temperament of the builders, nurtured in the context of a harmonious, peaceful society that was as one with nature. The Savage and Changeful expression of vegetation was thus one of the defining features of the Gothic (Ruskin, 1853).

Grotesqueness, or 'Disturbed Imagination', was the fourth of the essential characteristics of Gothic. This element was very briefly defined as the affinity to find enjoyment in the implausible and absurd as well as sublime imagery; it was, according to Ruskin, the "…universal instinct of the Gothic imagination" (Ruskin, 1853 p. 203). Undoubtedly, this definition can be argued as an extension of a Savage independent mind.

The fifth characteristic of Gothic architecture was Rigidity, or 'Obstinacy'. Rigidity was apparently difficult to define; however, it was tentatively defined as not only being stable but 'actively rigid'. In Ruskin's words, it was that strange power that gave tension to movement; opposition to movement; scattered the most powerful lighting; was seen in the trembling of the lance; and the sparkle of the icicle. As such, tracery and vaulting were rigid, like human bones or tree fibres, where elastic transferral of tension and force was evident in all aspects of the building. Likewise, Gothic *Rigidity* was also to be found in its ornament that projected in 'prickly independence', formed into pinnacles like frozen water, starting as a monster and then metamorphosing into a blossom via a knitted, thorny or writhed branch. However, it was the Gothic workmen who truly made Rigidity 'active' through their independence of nature, strength of will, unyielding purpose, non-acceptance of dictatorial control, and independence of thought (Ruskin, 1853).

The last of Ruskin's six characteristics was Redundance, or 'Generosity'. Redundance essentially revolved around the Gothic notion of humility, which could accept both the complex and simple, and that admitted the crudest of minds as well as the most refined. The Gothic achieved Redundance by masking the work of the inattentive, imperfect and feeble in the endeavour of generation of the unselfish collective through the accumulation of ornament. Likewise, the individual could only comprehend a small part of the universal natural sum, but collectively a community would complete a 'tapestry of traceries' in the Gothic cathedral (Ruskin, 1853).

Essentially, Ruskin's explanation of the characteristics of Gothic can be seen within the most basic of the tenets of Romanticism: the free expression of the intent or will of the artist and a close affinity with nature.

Romanticism and the affinity for the Gothic appeared to have ended in the mid-19th century. This could have been because the ideals of the French Revolution were effectively negated by the dictatorships of Napoleon and the return of the monarchist Bourbons. In the rest of Europe, nobility was likewise reasserting it authority and persecuting democrats. Similarly, in the second half of the 19th century, massive power shifts occurred in Europe, such as the unification of Italy in 1870 and Germany in 1871. The second half of the 19th century was a period of unbridled industrialisation in Europe, in particular Belgium and Germany, and their new-found industrial wealth undoubtedly led to the desire for colonial empires, both of which were subsequently established in the latter half of the 19th century.

Industrialisation also resulted in a logical shift towards urbanisation. As such, the reality of the industrial city-slums, pollution, overcrowding, disease and social breakdown led to a redirection from Romanticism toward Realism. However, the new reality of Realism could not fully suppress Romantic tendencies, which ultimately remerged in the artistic eclecticism of the late 19th and early 20th centuries. Movements like the European Art Nouveau and the British Arts and Crafts arguably contained elements of Romanticism. Therefore, in Germany during the first decade of the 20th century, the Gothic and Romanticism re-emerged in the writings of Wilhelm Worringer and Herman Muthesius.

5.4 Wilhelm Worringer

In 1907, Worringer published *Abstraktion und Einfühlung: ein Beitrag zur Stilpsychologie (Abstraction and Empathy: Essays in the Psychology of Style)*. In this document, Worringer developed Theodore Lipps earlier notions of *einfühlungs* (empathy); if people could empathise, or identify, with a work of art, they would logically find it beautiful because of their own sense of delight in themselves. Consequently, empathetic societies produced 'representational art', such as that produced in the Renaissance. Furthermore, 'representational art' meant that these empathetic societies would be confident in their space/time contexts. Conversely, 'abstract art' was derived from peoples who were insecure, anxious, fearful and uncertain of their space-time contexts. 'Abstract art' could be found in the societies of Egypt and Byzantium; likewise, it additionally included primitive and even modern Expressionist art (Worringer, 1907). In the last chapter of *Abstraktion und Einfühlung*, Worringer presented his initial thoughts on northern European 'representational art', i.e. the psychological *Kunstwollen* (artistic will, or 'the Will to Art') inherent in the Gothic. *Kunstwollen* was however not Worringer's creation; rather it was the Austrian art historian Alois Riegl who first developed the term (Riegl, 1893).

Worringer's (1907) initial thoughts concerning the Gothic were later expanded on in his book *Formprobleme der Gothik (Form Problems of the Gothic)* of 1910. Here, Worringer proposed that Gothic architecture was essentially an expression of the *Kunstwollen* of the men who had built the Gothic. In other words, *Kunstwollen* was inherent in the Gothic as a feeling of vitality that manifest as higher spiritual existence and ultimate salvation. As such, Gothic man created a transcendent Expressionism manifest in stone. However, Gothic man effectively dematerialised stone through creating form that, instead of being expressive of gravity, sought to reverse it, creating an unrestricted upward movement of free and uninhibited forces. By dematerialising it, stone was effectively spiritualised. Therefore, the Gothic form became a living, breathing body that both externalised its inherent longing for spiritual expression and structural reality. This synthesis of structural reality and desire for expression was most evident in the pointed arch, which was the system that ultimately guided the entire aesthetic of the Gothic cathedral. Worringer accordingly proposed that the whole interior effect of the Gothic cathedral was as a result of the pointed arch. From a structural perspective, the pointed arch allowed the vertical expression of a large enclosed space. However, from an expressive perspective, the pointed arch further allowed this large enclosed space to create the aspiration of a heavenward verticality.

The 'structure' of columns and vaulting thus became strained sinews that, once freed from material weight, then transcended terrestrial limitations. The column and vaulting likewise became one, with the expressive lines of the vaulting starting at the floor, then transferring up the column shaft and terminating in the dizzying verticality of the ceiling vaulting. This verticality of lithe, living forces was then naturally centred on a vaulting keystone that was as light as a flower. This arrangement therefore created an 'atmospheric space', which was spiritual, incomprehensible and directly affected and grounded in the human senses. But, more than an 'atmospheric space', the interior of the Gothic cathedral was further a 'super-sensuous space', which intoxicated and overpowered the human senses through the experience of unbridled activity. However, Worringer further contended that this 'super-sensuous space' found its ultimate expression on the exterior of the Gothic cathedral. In the towers, all the upward energy, movement and transcendent desires culminated in one final, delivering utterance. According to Worringer, nowhere else were all of the intoxicating, transcendental and ultimately mystical effects of the Gothic cathedral more evident than in its towers. Worringer, while crediting the French with the creation of the Gothic system, stated that it was the momentum or impulse inherent the *Kunstwollen* of the Germanic character that untimely bought it to its fullest manifestation. As such, Worringer proposed that the form of the Gothic was the result of the will and intent of the artists involved, rather than an expression of a wider artistic cycle. Therefore, Worringer made a call for a new abstract art that was drawn from both the intuition and the serrated geometry of the East and the Orient. This art form would transcend the chaos of the modern era through the creation of architecture that reflected order, truth, and spiritual clarity; a new art that was both independent and autonomous, and that was based on an intuitive, emotional and creative artistic awareness of form (Worringer, 1910).

In 1902, Herman Muthesius published *Stilarchitektur und Baukunst*. In this work, arguably all of the prior ideas of Goethe, Schinkel and Ruskin finally found a holistic expression. Furthermore, Muthesius' work, apart from impacting on the 'immediate' past of the Gothic, also connected the wider political, social and economic histories of the 18th and 19th centuries. These socio-economic connections were therefore ultimately more powerful, as they additionally incorporated personalities like Paxton, Borsig and van Houtte. Likewise, Muthesius' work also forcefully resonated into the future.

5.5 Herman Muthesius

Muthesius' association with religious buildings had an early start, because his father was a mason who owned a small construction firm that built country churches and designed church towers. Following his secondary schooling, Muthesius subsequently attended the Friedrich Wilhelm University in Berlin from 1881 to 1883, where he studied art history and philosophy. After a year of military service, Muthesius then enrolled to study architecture at the *Technische Hochschule* (Technical Institute) in Charlottenburg, Berlin. While undertaking his architectural studies, he also worked in the architectural practice of Ende & Böckmann (H. Muthesius, Günther, Posener, Sharp, & Muthesius, 1979). The founding director, Wilhelm Böckmann, had travelled to Japan in 1886, and his partner, Hermann Ende, in 1887. During this period, Ende & Böckmann presented a master-plan for Tokyo, along with numerous new government buildings (Lepik & Rosa, 2005). Likewise, from 1887 to 1891, Muthesius was also in Japan, where he supervised contracts for Ende & Böckmann, and completed a number of buildings that included a Gothic Revival church. On his return to Berlin in 1891, Muthesius completed a period of employment with the Ministry of Public Works, while also completing additional studies and travels in Italy. As a result of these studies, Muthesius, in a similar manner as Goethe, Schinkel and Ruskin before him, published his first book *Italienische Reise-Eindrücke (Italian Travel Impressions)* in 1898.

However, prior to this, in 1896, Muthesius was appointed as the German cultural and technical attaché to London. The primary purpose of this appointment was for him to study and report back to the German (Prussian) Government on British technology, art and architecture, and he subsequently published a number of books on the subjects. The first two of these books, *Die Englische Baukunst der Gegenwart (Contemporary English Architecture)* and *Die Neuere Kirchliche Baukunst in England (Recent Religious Architecture in England),* were both published while he was in Britain, while a third and arguably the most influential book, the *Das Englische Haus (The English House)*, was published after his return to Germany. Also published after Muthesius' return to Germany was the previously mentioned *Stilarchitektur und Baukunst*, which is the book most relevant to this study.

On his return to Germany, Muthesius was appointed to the German (Prussian) Ministry of Commerce where he was an ardent proponent of the knowledge that he had acquired in Britain; in particular, those lessons acquired from his study of the Arts and Crafts Movement. Muthesius accordingly proposed the integration of craft into all spheres of arts and architecture education, in the attainment of an artistically driven culture for the emergent German industrial society. Once he was released from the Ministry in 1904, Muthesius then continued to advance this goal through the establishment of his own architectural practice, as well as the founding of the *Deutsche Werkbund* in 1907 (Mallgrave, 1994).

In *Stilarchitektur und Baukunst*, Muthesius (1902) made an impassioned plea for the renewal of German culture through the medium of high-quality, industrial goods. However, unlike the British example of the Arts and Crafts Movement, which, according to Muthesius, had restricted modern change and was ultimately the preserve of the privileged classes, the German version would be solely aimed at the middle classes and actively embrace modern industrial change. Muthesius therefore envisioned a resultant middle-class art that was to distinguish itself through the fundamental embodiment of *Sachlichkeit* (Objectivity or Reality), or its adjective *sachlich* (practical, functional or pragmatic) (Mallgrave, 1994). Muthesius (1902) contextualised his argument for this new middle-class *sachlich* art within the premise that all the artistic production since the demise of the Gothic was essentially a cacophony of meaningless styles, or *Stilarchitektur.* Nowhere else was the disharmony of *Stilarchitektur* more evident than in the 'mother of the arts', architecture. Consequently, architectural styles like Gothic Revival, Art Nouveau and *Jugendstil* were simple *Stilarchitektur* with no *Sachlichkeit.* To remedy this situation, Muthesius argued that the genuine new forms of 19th-century industrial buildings and new material essence of glass and steel, in particular railway stations and exhibition buildings, offered the solution:

> England showed the world the way in exhibition architecture with the construction of the Crystal Palace for the first world exhibition in 1851. … The Crystal Palace was built by a gardener, the subsequently knighted Joseph Paxton … His experience with greenhouses brought him to this singular construction of iron and glass. In Paxton's time it was hardly considered architecture, and yet his prototype opened the way for a new architectonic phenomenon of the following decades: the wide-span iron framed hall. This construction was particularly suited to a series of exhibition palaces for world expositions in France. … The most splendid accomplishments of iron architecture were realized in the great Galerie des Machines and the Eiffel Tower of the exposition of 1889. These were works in comparison to which all the buildings of the last world's fair (Paris, 1900) represent an embarrassing regression. This step backward was, in any case, already anticipated in America. To the astonishment of a world expecting something quite new, the Americans, at the Columbian Exposition of 1893 in Chicago knew nothing better than to hang a familiar antique masquerade costume on the iron ribs of its exhibition halls. However enchanting this fairy tale image may have been, this backward-looking production counted for less than nil… (Hermann Muthesius, 1902 pp.41-2).

As such, contained within these railway stations and exhibition buildings were the modern ideas and principles of progressive design. Therefore, these rigorous, logical and scientific buildings firmly embodied the desired *Sachlichkeit* (Mallgrave, 1994). However, what was not evident in the new *sachlich* industrial architecture were the desired supportive social conditions. Like many authors before him, Muthesius (1902) therefore proposed Gothic society as the solution. His version of the Gothic took the Romantic thoughts of authors like von Görres, Pugin and Ruskin and added the Realism of German industrialisation. Like almost all the authors mentioned above, Muthesius likewise argued that the Gothic was the unique creation of northern European peoples, wholly independent of the prevailing classical model. Using this as a starting point, Muthesius then proceeded to add the Realism of context.

Muthesius started this discussion by exposing the modern and wholly national art and architecture, which derived directly from the Gothic in Britain after 1860. The British people had inundated themselves within the new ideas that derived from this concern with the Gothic. The characteristics of this new British art were sound workmanship, reasonableness, and sincerity, while its motive was a genuine and popular local enthusiasm for art. According to Muthesius (1902), the father of this modern British art was William Morris and its propagandist was John Ruskin. However, within continental Europe, a similar situation was not possible because of the prevalence of classical conceptions of beauty that derived from Greece and Italy. To remedy this situation, Muthesius proposed the British-Gothic model as the solution, albeit with numerous modifications. The most significant of these modifications was that while he recognised that Morris' social vision had failed—in that it maintained the status of the ruling classes—he acknowledged that the desirable work, craft and product outcomes of Morris had been achieved within an idealised industrial context (Mallgrave, 1994). On the other hand, Muthesius (1902) proposed to transplant the Gothic version of society into the modern German industrial context. This Gothicised society was explained as a construct during which art and architecture were common cultural property and were thus highly valued. This art and architecture perfectly mirrored the context of its period, and permeated all of its contemporary expressions of life. A unified cultural model of both art and architecture was therefore applicable and evident in all levels of society. And, it was this holistic inclusion of all members of society, especially the middle classes, that would set Muthesius' (1902) Gothicised society apart from the failings of the British model.

A further shortcoming of the British-Gothic model had to do with the instruments of its industrial society, i.e. the machine. Mirroring Ruskin, Muthesius (1902) argued the English Arts and Crafts Movement had overtly condemned machine products because they produced 'false works of art' that ultimately resulted in an undercutting of prices and therefore a decline in quality. Machine production affected the worker, the consumer and the nation. The worker earned less, lost interest in his work, and was 'spiritually injured' because he had to produce inferior articles. The consumer acquired a 'false economy' in which he was obliged to participate in an artificially constructed consumer society through the acquisition of inferior quality goods. (Therefore, the worker became the focus of the consumer's wrath in relation to poor quality goods.) Likewise, the nation was also affected because it had to import expensive raw materials to produce these 'false works of art'. But, unlike the English Arts and Crafts Movement, Muthesius proposed that the machine should be actively employed in his new Gothicised society. However, in this new society the machine would not expel cheap mass-produced rubbish; rather, it would produce quality *Sachform* (the undecorated forms or products of *Sachlichkeit*) from which the worker would then assemble into *sachlich* artefacts. These *sachlich* artefacts would more than compensate for any increase in price through a dramatic increase in quality. Additionally, both the worker and consumer would be drawn closer, in that both now would take personal pleasure in crafting and consuming a higher quality artefact. The progress required to bring about this Gothicised society would require that the whole nation acquire an understanding of quality. Therefore, the state, as the ultimate demander of quality in the products that it procured, was to be the teacher (Hermann Muthesius, 1902).

Muthesius’ (1902) concern for *sachlich* artefacts extended further than individual machine produced forms; it additionally concerned both the shape of German industrial cities and its constituent architecture. Apart from endorsing both Schinkel as the last notable architect who unified architecture and art and Alfred Messel’s Wertheim Department store, Muthesius once again returned to the precedents offered during his stay in Britain. As such, he proposed that the domestic, vernacular-inspired architecture of Richard Norman Shaw held the solution, for the future direction of architecture. In Shaw, Muthesius (1902) saw a simple and natural architecture that derived from the customs and practices of the small towns and rural landscapes of Britain. The resultant architecture that adapted to local needs and conditions was therefore instilled with unpretentious and honest feelings. As such, Shaw’s domestic architecture, or ‘artistic house’, created the only convincing basis for a new artistic culture.

While the conditions for such architecture were available in Britain, they were not yet present in Germany. Thus, Muthesius proposed that if Germans wanted to create the correct conditions, they would have to have exposure to both journals and exhibitions. A further source of inspiration, which was both surrounded by poetry and rich in sentiment, was the vernacular tradition present in German rural architecture. Muthesius was also careful to state that the unpleasant architectural character of contemporary German cities, with their collective consumption, false sensibilities and American tempos, was a hindrance in the creation of the desired, natural and healthy artistic condition. This was because an authentic art could only result from authentic *Sachlichkeit* feelings and people born of Germany (Hermann Muthesius, 1902).

5.6 Muthesius and the *Deutscher Werkbund*

In the late 19th century, Germans realised that they could only effectively compete with established trading nations, in particular Britain, if they offered improved design and vastly superior quality. As such, Muthesius, Friedrich Naumann and Karl Schmidt founded the *Deutscher Werkbund* in 1907. The initial membership of the Werkbund included 12 individual artists and 12 industrial, or craft, firms (Frampton, 2007). The *Werkbund* promoted the term *Qualität* (Quality), which was a holistic ethos that both embodied the raising of the standards of design and used the finest materials, in combination with the very best of talent. *Qualität* would accordingly bring about the desired cultural reintegration and rejuvenation that Muthesius and his peers so actively sought (Mallgrave, 1994). Between 1907 and 1914, industrial membership of the *Werkbund* grew from 143 to almost 300 (Maciuika, 2005). Considering the diversity of the *Werkbund's* membership, very soon after its establishment, a rift appeared between those that preferred prescriptive or set forms and those that favoured individual artistic free-will forms. These issues came to head at the Werkbund meeting in 1914, at which Muthesius proposed the production of *Typisierung* (Standardisation) for both domestic and international markets. This was quickly countered by a proposal for artistic individualism from a group led by Henry van de Velde and that included Bruno Taut (Maciuika, 2005). Mallgrave (1994) is correct in arguing that, before 1914, Muthesius never used the term *Typisierung*. Mallgrave further argued that in keeping with Muthesius' earlier thoughts, *Typisierung*, rather than meaning standardisation, instead implied the formation of norms that would have been equally be applied to architecture, crafts and industrial products. As such, *Typisierung* can rather be seen as shared conventions of practice, which would have brought about the required harmonious and unified culture that Muthesius desired (Mallgrave, 1994).

As a participant in the wider debate concerning individual versus prescriptive form, Bruno Taut expressed his thoughts as early as 1904 in both "Natur und Kunst" and "Natur und Baukunst". Taut wrote the former while in the employ of Theodore Fisher in Stuttgart. Fisher who was one of the later 12 founders of the *Werkbund* (Junghanns, 1983). In it, Taut stated that the architecture of his time was less about the authenticity of any particular style (*Stilechtheit*), but rather about the free artistic will or power (*freie künstlerische Kraft*) of a 'master', who, without renouncing tradition, created a new architecture from both the technical and aesthetic traits of his present context. This joyful development owed its existence to the fact that a new generation of architects once again studied nature. Stating that he dismissed the idealistic notions concerning the rural village, Taut (1904b) alternatively proposed that the rural village rather had a close and intimate affinity to nature. Not only was the rural village derived from nature, but it also had the same origin as both the forest and the mountain. Taut then proposed that young architects should endeavour to ‘feel’ the same affinity or connection toward, and with, nature as the rural village. To demonstrate this somewhat vague point, Taut (1904b) illustrated the nave of a Gothic church and a forest (*Tannenwald*) of

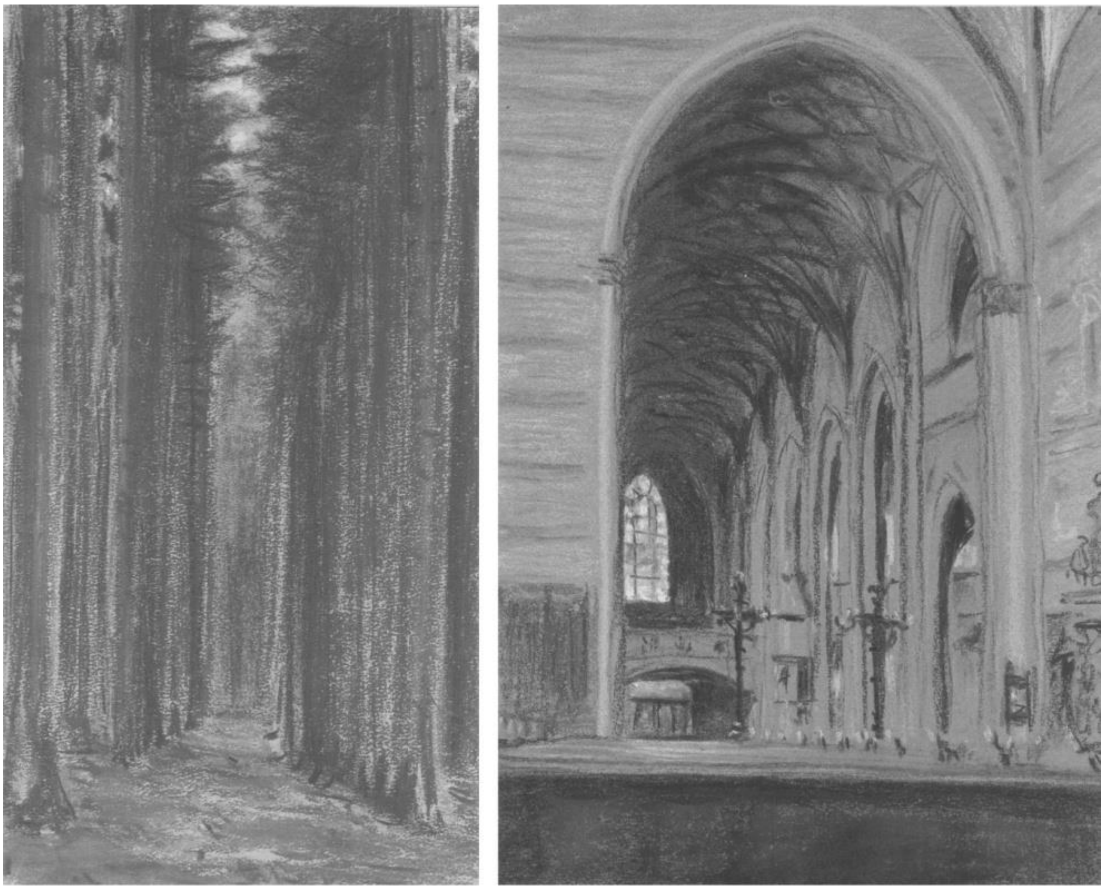


Figure 127 Bruno Taut’s illustrations of a *Tannenwald* and the interior of Stuttgart’s *Stiftskirche* (Image: Thiekotter, 1993).

either fir or pine trees (Figure 127). Taut continued by stating that while the Gothic pointed arch and vaults were not directly present in the forest, they were there as the ‘free will’ interpretations of the architect. This was because the architect could never directly reproduce nature, but only offer a picture, image or interpretation of its glory. To further emphasise his point, Taut then quoted directly from John Ruskin’s *The Stones of Venice* (Ruskin, 1880 p.353-4):

> We are forced, for the sake of accumulating our power and knowledge, to live in cities, but such advantage as we have in association with each other is in great part counterbalance by our loss of fellowship with nature. We cannot all have our gardens now,

> nor our pleasant fields to meditate in at eventide. Then the function of our architecture is, as far as may be, to replace these, to tell us about nature, to possess us with memories of her quietness, to be solemn and full of tenderness, like her, and rich in portraitures of her, full of delicate imagery of the flowers we can no more gather, and of the living creatures now far away from us in their own solitude (Taut, 1904b p.51).

Taut then concluded "Natur und Kunst" by describing two drawings that, apart from having direct relevance to the content of his article, were also additionally dedicated to his studies: one of a *Tannenwald* on the outskirts of Stuttgart and another of the interior of the *Stiftskirche* in Stuttgart (Taut, 1904b).

Taut's second article, "Natur und Baukunst", which can be seen as a refinement of the first, further elaborated on nature as a source of inspiration for architecture, in that it offered an extremely delicate sense of space organisation. Taut proposed that the Gothic cathedral triggered in the viewer a sense similar to that of the space formation of nature, but only when viewed as an entirety and in a peaceful and devoted manner. Based on this, Taut proposed that the ultimate role of the architect was to interpret nature and create architecture that unconsciously and involuntarily evoked in the viewer the sense of a natural environment - be it the starry night sky or the mountains. Taut, once again, referred to the two images published earlier in "Natur und Kunst", stating that while both images were different in their detail, they were essentially the same. Likewise, one image was not directly imitating the other; rather the result was an independent, creative, and natural architecture that was achieved through the architect's 'free will' to imagine space (Taut, 1904a).

From the above explanation of Taut's early writings, it is clear that he was under the influence of a long line of Romantic thought that culminated in Muthesius' *Stilarchitektur und Baukunst.* However, it was not Muthesius who appears as directly influential on these two articles; rather it was Ruskin. Apart from the direct quotation of Ruskin's *The Stones of Venice* in "Natur und Kunst", Taut's two works are additionally littered with other references to Ruskin, since he refers to *Savageness, Changefulness and Naturalism*. Likewise, Taut's instance of 'quiet contemplation' in "Natur und Baukunst" derives directly from Ruskin.

In 1914, Taut published “Eine Notwendigkeit”. This article can be seen as a later elaboration of Taut’s earlier quotation of Ruskin and the Romantics, in that the architecture that best compensated for the loss of nature in the city was embodied in the Gothic cathedral. As already shown, “Eine Notwendigkeit” elaborated on the perceived collaborative effort that was personified in the Gothic cathedral as a building that that was the collective endeavour of architects and artists, and, in particular, painters. Taut (1914a) thus called for the construction of buildings where architecture could once again merge with the arts. Taut envisaged a building much like a Gothic cathedral, which would be the ‘entirety’ of all its artistic endeavours. This entirety, or collective endeavour, was proposed by Taut as a ‘secret’ or ‘great architecture’. Much like the great Gothic cathedrals, Taut stated that the proposed building need not be finished by any one generation. Taut continued that the building must be everything at once, both frame and content, set free from practical demands. Taut proposed a house in which art was to be displayed and kept safe, a building that might contain rooms for all manner of artistic purposes. For Taut, this building was to have been an artistic organism that contained great stained-glass windows, walls in Cubist rhythms, paintings by Wassily Kandinsky and Franz Marc, columns decorated by Alexander Archipenko, and ornament provided by Heinrich Campendonk (Taut, 1914a).

But how does any of the above argument directly concern the actual design of the *Glashaus*? As stated previously, this study primarily seeks to propose alternative explanations for the origins of the *Glashaus*, and this chapter specifically attempts to answer this question in the context of the Gothic. Clearly, the above explanation of the Romantic and Gothic theoretical underpinnings of the *Glashaus* would therefore firmly position it as a continuation of this process. The most important connection to this process would have been the creation of a building that was an entirety, or collective endeavour, and one that was proposed by Taut (1914a) as a ‘secret’ or ‘great architecture’. Considering the large number of firms, artists and personalities involved, such as the *Deutsche Luxfer Prismen Syndikat*, J. Schmidt and Gottfried Heinersdorf, *Zwieseler und Pirnaer, Eduard Liesegang Fabrik Optischer Apparate,* the Auer Company, Bruno Taut, Paul Scheerbart, Franz Mutzenbecher, Adolf Holzel, etc., it is clearly evident that the *Glashaus* was undoubtedly a ‘secret’ or an example of ‘great architecture’. Furthermore, this quest for a ‘secret architecture’ clearly resonates with what Goethe (1772) referred to as the ‘secret powers’ of the Strasbourg Cathedral’s towers and the sparkling of the building in the early dawn mist. Taut, like Schinkel before him, executed the personal act of climbing Strasbourg Cathedral tower in 1920.

However, the above investigation has also exposed certain facts, such as Taut’s affiliation to the *Stiftskirche* in Stuttgart, which could be relevant in determining alternative origins for the *Glashaus*. Consequently, these are further avenues worth pursuing.

5.7 Imitating the Gothic masters

From the two images published in “Natur und Kunst”, it is apparent that, for Taut, the Gothic nave of Stuttgart’s *Stiftskirche* evoked in him the image, or sense, of being in a *Tannenwald* on the outskirts of Stuttgart. Alternatively explained, the *Tannenwald* served as the original, or natural, inspiration behind the ‘free will’ conception of the *Stiftskirche*’s nave. In comparing the two images, it is relatively easy to comprehend as to why Taut would have made this comparison. For example, the overall space organisation of the two is similar in that the space depicted between the two parallel rows of trees could be the volume of the nave, as defined by the two parallel rows of columns; the flared bases of the trees could

Figure 128 Left - Interior of the nave of St. Lamberti in Münster. Right - The nave of St. Martin in Amberg (Images: Taut, 1904b).

relate directly to the expanded bases of the gothic columns; the trunks of the trees are clearly the shafts of the church columns; and the top of the trunks could be the column capitals. Furthermore, the high branches of the trees could be the projecting ribs to the underside of the nave's vaulting.

The *Stiftskirche* was constructed according to the *Staffelhalle* (Pseudo-Basilica or Hall-church) principle, which dictated that when viewed in section, the central nave was the tallest portion of the building and that the outermost aisles were not as tall as the innermost aisles. The *Staffelhalle* principle also dictated that the nave should have no clerestory windows. Hänslin Jörg, the architect of the *Stiftskirche's* nave, began working on it in 1433. However, it was not until 1495 that Hänslin's son, Aberlin, completed the rib vaulting over the nave (Nussbaum, 2000). As stated above, when the original 1495 vaulting is compared to the structure of the *Glashaus'* dome, they appear as remarkably similar. This similarity even extended to the point where the dome structure of the *Glashaus* could very well be argued as

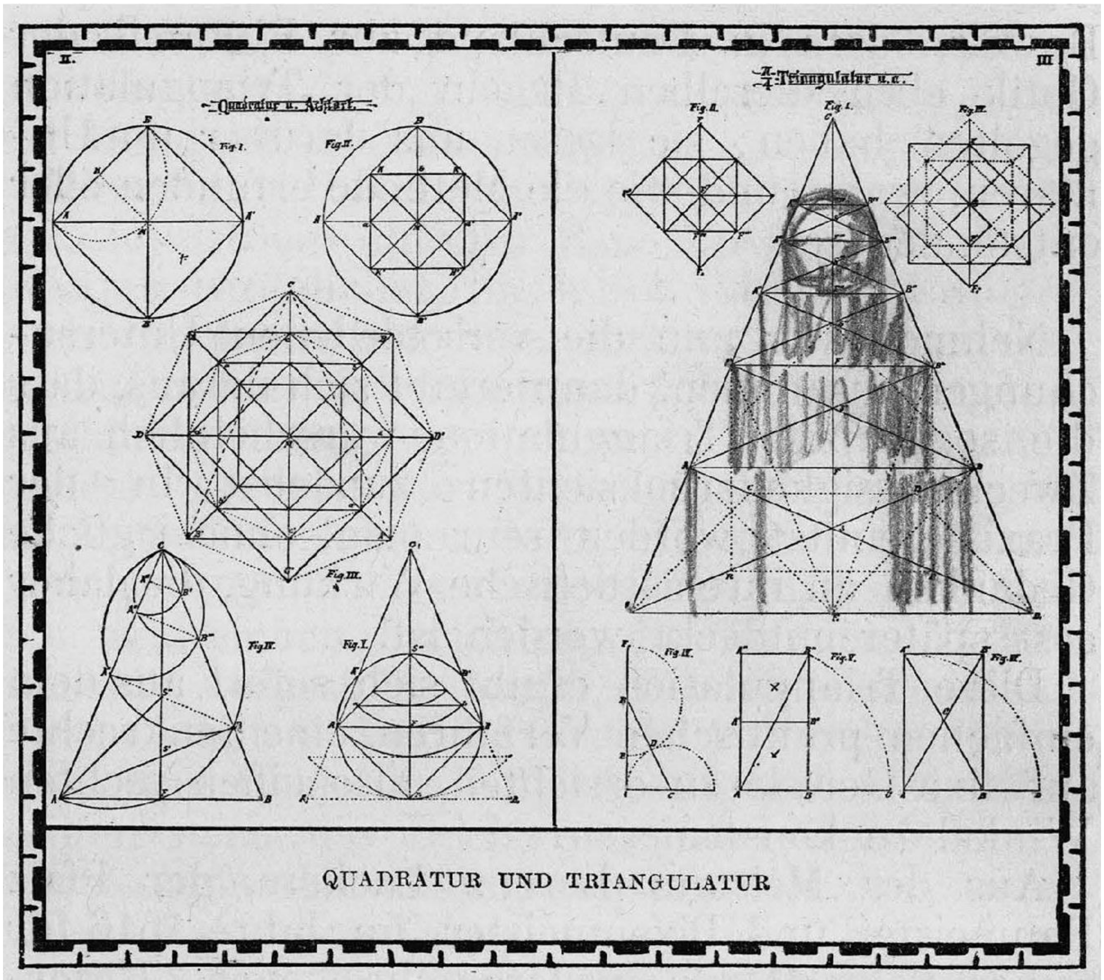


Figure 129 Taut's illustration over an image in his copy of *Grundlagen und Entwicklungen der Architektur* (Images: Nussbaum, 2000).

identical. However, this similarity is not only unique to the *Stiftskirche.* Indeed, the aesthetic of the *Glashaus*' dome could likewise be proposed as similar to that of the naves featured in St. Martin (1421-83) in Amberg, and St. Lamberti (begun in 1450) in Münster (Figure 128). Furthermore, the rib vaulting to the lower aisle of the *Stiftskirche* is proposed as similar to that above the aisle of St. Mauritius (1433-83) in Olmütz. When the general aesthetic of the space organisation inherent in these gothic rib vaults is compared to the dome structure over Taut's 1914 *Glashaus*, it becomes apparent that they are, as Taut would have contended, essentially the same thing. However, while the Gothic rib vaulting, in particular, in Stuttgart's *Stiftskirche,* was undoubtedly influential in Taut's formative thinking for the dome structure of the *Glashaus*, it could be argued as simply a direct imitation rather than a 'free will' interpretation.

A yet unpublished imitation of Gothic thinking is additionally obvious in the *Glashaus*. As mentioned before, Hendrick Berlage was important to the development of Taut's thinking and the development of "Eine Notwendigkeit". This connection was primarily established though Berlage's 1908 publication *Grundlagen und Entwicklungen der Architektur*. As presented above, Taut supposedly became aware of this publication through Behne, from whom Taut requested a copy in April 1913 (Gutschow, 2005). However, new evidence supports the fact that Taut had a copy of *Grundlagen und Entwicklungen der Architektur* three years prior. In 2013, Robin Rehm published an article entitled "Nieznany rysunek Brunona Tauta Historia projektu Monument des Eisens (Pomnik Żelaza) z 1913 roku" ("Bruno Taut's Unknown Drawing. A History of a Design for *Monument des Eisens* (*Monument of Iron*) of 1913"), in which it was revealed that Taut already had a personal copy of *Grundlagen und Entwicklungen der Architektur* in 1910. Aside from this, what is most remarkable about Rehm's (2013) article is the fact that it mentions Taut as having personally drawn over a particular image in the book (Figure 129). According to Rehm, the resultant illustration is a conceptual elevation of Taut's 1913 *Monument des Eisens*, while the original image over which Taut drew was a system that, according to Berlage, was used to proportion Gothic architecture (Rehm, 2013). This Gothic proportioning system was based on multiples of the square root of 2, i.e. 1.41421356. Furthermore, the image that Taut drew over was an isosceles

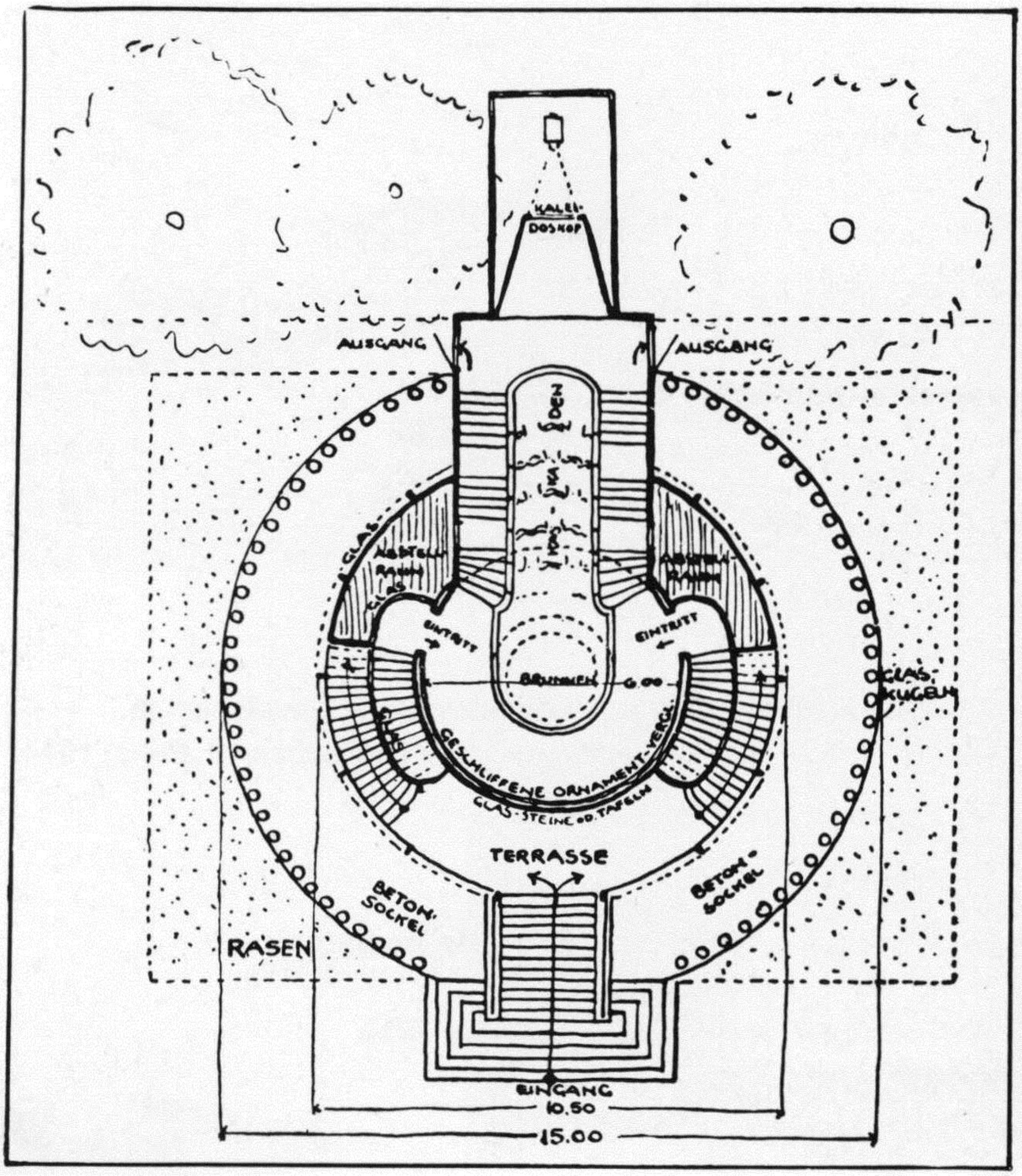
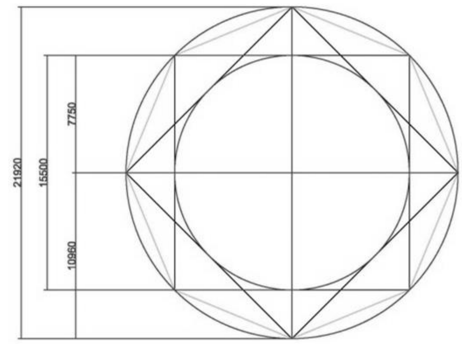


Figure 130 The preliminary plan of the Glashaus, 1 January 1914 (Image: Rehm, 2013).

triangle that derived from a system of squares, which were in turn proportioned according to the square root of two.

The most obvious aspect of the *Glashaus'* plan was its central planning, expressed as a number of concentric circles (Figure 15). Curiously, on the plan that Taut and Hoffmann submitted to the Cologne City Authorities, which was dated 25 February 1914, some of these concentric circles had strange overall dimensions, i.e. these dimensions are correct to within one centimetre. For instance, the outer dimension of the 14-column base that supported the *Glashaus*' dome was 11.06 metres, and the inner wall that surrounded the staircases had an inside diameter of 5.78 metres. These strange dimensions are however contrasted with other dimensions that can be considered as conventional. For instance, the overall dimension of the flared concrete base that surrounded the *Glashaus* was 15.5 metres, and the outer dimension of the head of the fountain had a diameter of 2.8 metres (Taut, 1914b) (Figure 15). However, on the preliminary drawings that Taut made public on 1 January 1914, the dimensions were slightly different in that they were exclusively conventional. For instance, the *Glashaus* dome was noted as having had a diameter of 10.5 metres, the flared concrete base that surrounded the *Glashaus* was dimensioned as having been 15 metres, and the inner wall that surrounded the staircases had an inside diameter of 6 metres (Figure 130). Hence, at some point between 1 January and 25 February 1914, numerous changes were made to the *Glashaus'* dimensions.



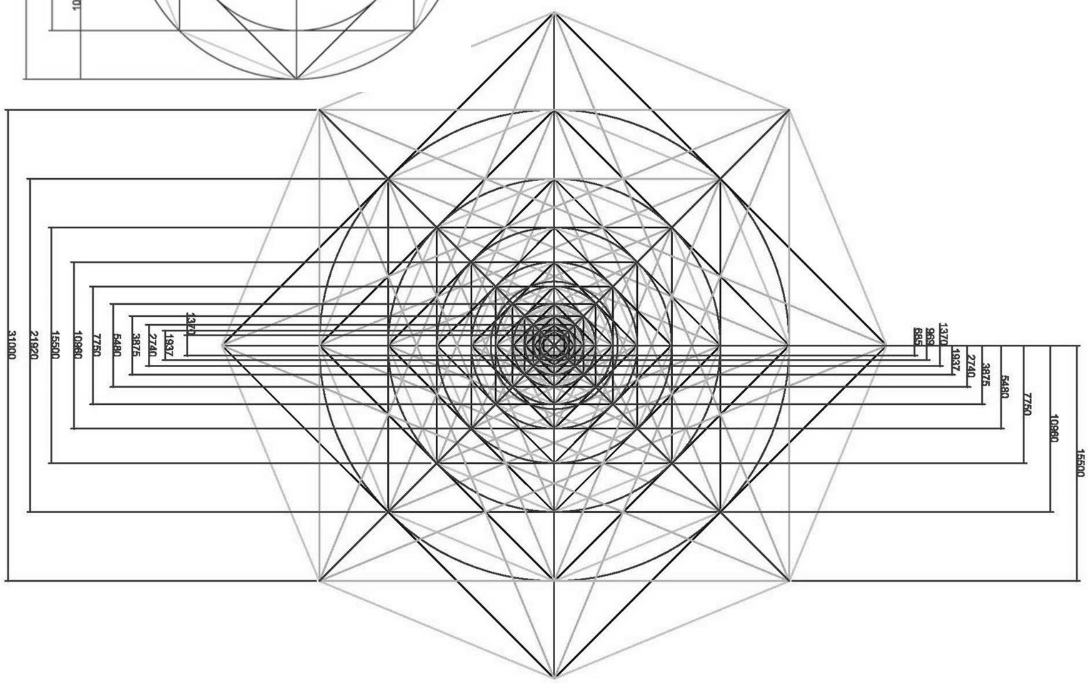


Figure 131 Top – The initial 'geometric seed' using the number 15.5 metres (Image: By author).
Figure 132 Bottom – Scaling the initial 'geometric seed' by the square root of two, or 1.41421356 (Image: By author).

As has already been mentioned, Held (1993) contended that construction work to the *Glashaus* had apparently commenced two weeks prior to the issue of the building permit, i.e. two weeks prior to 25 February 1914. Hence, these dimensions were likely applied to the *Glashaus* five to six weeks after 1 January 1914. Thus, the later tendency for dimensional accuracy i.e. on the plan that Taut and Hoffmann submitted to the Cologne City Authorities, would tend to indicate some rapid and yet unknown desire for either exacting mathematical or absolute geometric accuracy.

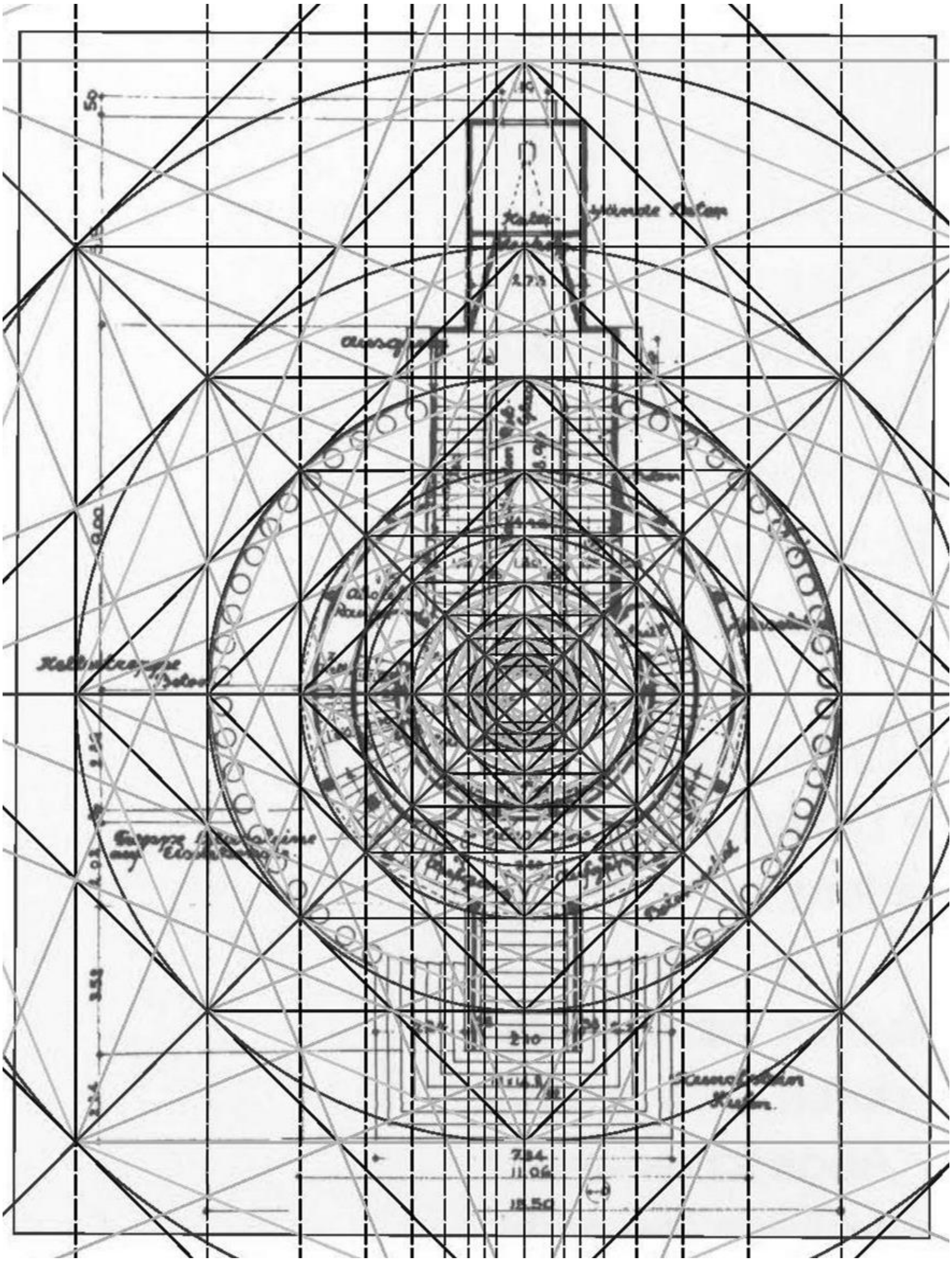


Figure 133 Overlaying the scaled 'geometric seeds' onto the plan of the *Glashaus* (Image: Junghanns, 1983).

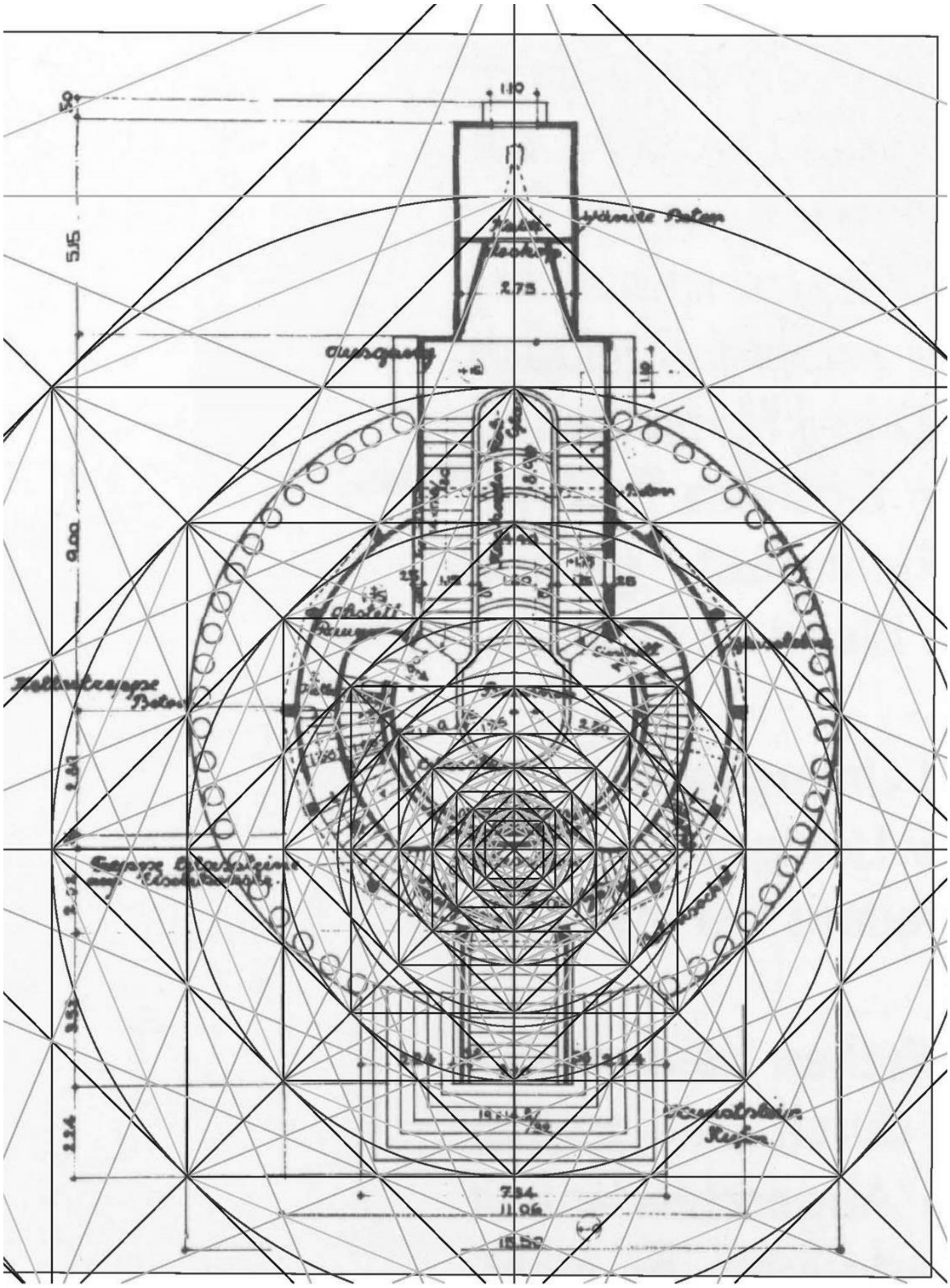


Figure 134 Moving the origin of the scaled 'geometric seeds' on the plan of the *Glashaus* (Image: By author using an overlay of Taut, 1914b).

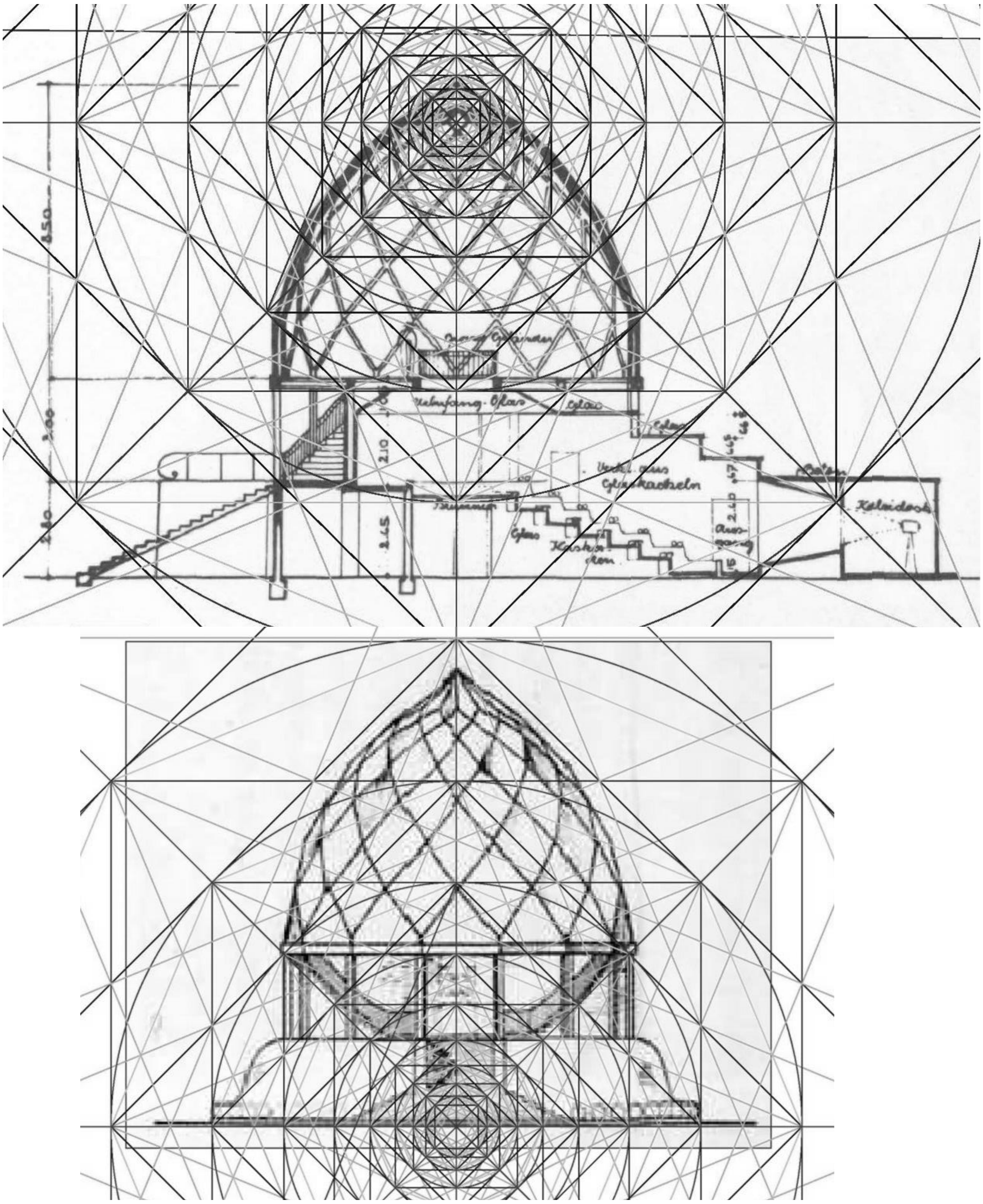


Figure 135 Overlaying the scaled ‘geometric seeds’ onto a section and elevation of the *Glashaus* (Image: By author using an overlay of Taut, 1914b).

As detailed above (Figure 19), prior attempts have been made by the author to connect the planning of the *Glashaus* to a geometric proportioning system. However, none of these were entirely successful. Considering Taut’s acknowledged interest in the Gothic, Berlage’s prior dictation of a Gothic proportioning system, and Taut’s firm connection to prior use of Berlage’s proportioning system in the *Monument des Eisens,* it would be logical to attempt to apply Berlage’s proportioning system to the *Glashaus*.

Thus, taking the dimension of 15.5 metres as a starting point, a square with a breadth and length of 15.5 metres was constructed. A second square with identical dimensions was then added. This second square was however rotated 45 degrees along the intersection of the first square's diagonals. An isosceles triangle was then inscribed over these two squares, producing its base from the lower edge of the first square and its height by the most-distant angle of the second square. This process was then repeated to produce a total of four triangles, but with their bases either parallel or at 90 degrees to the first. By connecting the corners of the two squares, a regular eight-sided polygon was then constructed. Furthermore, a circle was additionally inscribed over the two squares and polygon, using the intersection of the squares' diagonals as its centre. This resultant circle therefore also had a diameter of 21.92 metres, i.e. 15.5 multiplied by the square root of two. This final figure can be considered as the initial 'geometric seed' (Figure 131), which was then scaled according to the square root of two, or 1.41421356. This produced a series of proportional 'seeds' that are listed according to the diameter of their associated circles: 0.685, 0.969, 1.370, 1.937, 2.740, 3.875, 5.480, 7.750, 10.960, 15.500, 21.920 metres, etc. (Figure 132).

When this final diagram was overlaid and centred on the plan of the *Glashaus* by the author, numerous similarities immediately became evident. The most obvious of the similarities is the almost exact convergence of 'geometric seed' circles with the concentric circles of the *Glashaus* plan (Figure 133). In certain instances, where the circular arrangement of the plan did not coincide with the circles of the scaled 'geometric seeds', another method was used by the author. In these cases, a circle that intersected with the meeting points between the squares and-or the triangles can however be drawn. Certain other key dimensions can likewise be determined if the origin of the 'geometric seed' is moved up and down on the *Glashaus* plan, so that its 'seed' is centred on the intersections of the squares and circles, rather than its centre (Figure 134). Likewise, when the scaled 'geometric seeds' are placed over both the front elevation and the section of the *Glashaus*, immediate similarities are evident (Figure 135).

Therefore, this process proves that Taut used the above described geometric system to finally proportion the *Glashaus*. However, it has to be acknowledged that not all of the dimensions of the scaled 'geometric seeds' are an exact fit with the *Glashaus'* indicated dimensions. This minor discrepancy could in all probability be explained in one of two ways: firstly, Taut's ratio was not the exact square root of two, i.e. 1.41421356, but was rather closer to 1.4. Secondly, Taut could have used the ratio not in a strictly mathematical sense, but rather more as an indicative proportion gained from initial drawing and subsequent scaling of dimensions. This later argument is supported by Berlage's (1908) argument that there were significant variances in Gothic architecture due to the fact that dimensions were gained from geometric drawing and subsequent scaling, rather than pure mathematics.

5.8 Conclusion

One interesting fact about the *Glashaus* was its physical proximity to the Cologne Cathedral. However, it does not appear to have been the most significant Gothic example for Taut despite its proximity. In accord with the dismissal of the Cologne Cathedral by Schinkel, and the revelation that it was modelled after Amiens Cathedral, Taut too appears to have given it little attention. It receives no recognition in Taut's writings at all, and the execution of the *Glashaus* displays little evidence of its influence.

What has been demonstrated is that when Taut's Gothic writings are contextualised, they are clearly part of a much longer tradition of similar practices that revered the Gothic. Clearly, Taut's interest in the Gothic, contained within the powerful metaphor offered by Strasbourg Cathedral, partly derives from the important literary precedents offered by authors like Goethe, Schlegel, Schinkel and Ruskin. However, Taut's interest in the Gothic can also be explained in spheres outside of writing. Taut additionally mirrored the physical acts realised by these personalities, like climbing the Strasbourg Cathedral's spire. Within this wider context, it therefore becomes very clear why Taut would have copied the vaulting of the Stuttgart *Stiftskirche* and Gothic proportion, into the *Glashaus*. By mirroring these acts and keeping the Gothic tradition alive, Taut effectively breathed life into a very important constituent of his developing milieu. Taut was obviously connecting the *Glashaus* to tradition and precedent, or reconfiguring the historical conception of the Gothic into his contemporary setting.

Thus it can concluded that Through the connection of a number of progressive clients and products, but principally those of the *Deutsche Luxfer Prismen Syndikat*, to the *Glashaus* endeavour, Taut was transplanting the Gothic collective endeavour and societal transformation into the contemporary ideals of the *Werkbund*.

Chapter 6: Conclusion

6.1 Introduction

This study has uncovered some of the original motives and inspirations behind the design of the *Glashaus,* which have been largely overlooked. It has re-established the primary importance of the client–architect relationship between Frederick Keppler and Bruno Taut. Keppler, as the project's client, urged a rigorous and predefined prototype for the design of the *Glashaus*. In turn, Taut, as the architect, developed this stipulation into the *Glashaus* design through his interpretations of the *Victoria regia* lily, in addition to architectural precedents associated with Strasbourg Cathedral and the Stuttgart *Stiftskirche*. The common feature between these sources is a proportioning system based on the Gothic norm of the square root of two.

6.2 Myths, symbols and personalities

Frederick Keppler is thereby reintroduced as a key personality in the *Glashaus* narrative. While in the United States of America, Keppler developed an association with the Luxfer Prism Company, and when he returned to Europe in 1898, as the company's German representative, he sought to diversify and aggressively promote Luxfer's products. In particular, Keppler wished to introduce Luxfer's primary product, Luxfer Prisms, to a European audience and to promote it as a symbol of a progressive modernity. Keppler further refined the key technologies of the Luxfer Company. He introduced simplified glass tiles and a reinforced concrete joining system. Inevitably, Keppler sought a platform to promote these innovative new products. Bruno Taut and the *Glashaus* were chosen to accomplish this task because of the avant-garde character of his architecture.

In striving to attain his goals, Keppler proved highly influential in the development of prototype exhibition buildings displayed at numerous exhibitions. The Luxfer prototype found its ultimate expression in the *Glashaus*. However, the prototype did not emerge in isolation. Rather, it evolved from earlier exhibition buildings, most notably the glazed buildings featured at both the 1893 Chicago and

1900 Paris World Fairs. This study has argued that it was Keppler's personal experience of these earlier exhibitions that drove the development of the Luxfer prototype in Berlin. As the Director of the *Deutsche Luxfer Prismen Syndikat*, Keppler mandated that any iteration of the Luxfer prototype should use Luxfer products as the main building material and that it should showcase these in the best possible manner. To achieve these ends, Keppler further specified that the proposed exhibition building should contain a glazed dome, an elaborate structure to support the dome, spiral staircases, and a cascading fountain.

Considering the comprehensive brief outlined by Keppler, the architect selected for the brief would have few options other than to engage with these highly detailed requirements. This thesis asserts that this is what Bruno Taut did. Yet, Taut also lent an innovative interpretation to the project by introducing the themes and the poetic vision offered by Gothic architecture and the *Victoria regia* lily.

From the Gothic, Taut borrowed the vaulting from the Stuttgart *Stiftskirche*, and applied it to the structure of the *Glashaus'* dome. Likewise, the western rose window of Strasbourg Cathedral had an influential impact on Taut in determining the general planning of the *Glashaus* and the colours of its dome. And in this context, as already mentioned, Taut proportioned the overall *Glashaus* structure according to the Gothic norm using the square root of two.

A further source of symbolic interpretation, if not direct copying, can be derived from the influence of the *Victoria regia*. The general appearance and plan of the *Glashaus* is very similar to the post-1860 *Victoria regia* glasshouses, which were executed according to a circular or polygonal plan, which were in turn covered by flattish curved, glazed domes. More specifically, this thesis has shown that the planning of the *Glashaus* drew directly from the *Victoria regia* glasshouse at the Berlin Botanical Gardens in Dahlem.

Taut was aware of the symbols of the Gothic and the *Victoria regia*. As discussed, Hendrick Berlage revealed to Taut the Gothic proportioning based upon the square root of two. In addition, Taut imitated Schinkel's act of climbing a tower of Strasbourg Cathedral, and he was also familiar with the discourse surrounding the Gothic by important figures like Goethe, Schlegel, Ruskin and Worringer.

The dimension of the *Glashaus* dome also suggests prior knowledge of the work of Paxton, van Houtte and Ortgies, who all had an intimate association with the *Victoria regia*. Likewise, Taut's essay "Die Galoschen des Glucks" demonstrates that he was intimately aware of the anatomy and pollination habits of the *Victoria regia*, and this knowledge is also evident in the physical form of the *Glashaus*.

All the evidence presented here strongly points to the fact that crucial aspects of the *Glashaus* design drew upon the influence and impact of the Gothic and *Victoria regia*. Indeed, their presence is unmistakable and undeniable. Furthermore, this thesis proposes that, despite Keppler's detailed brief, Taut produced a design that imaginatively interwove his interpretations of the Gothic and the *Victoria regia* into the *Glashaus.* By doing so, Taut achieved something far more significant than the highly circumscribed brief might have originally suggested possible.

6.3 Implications

The research undertaken in this thesis and the answers it produces pose a number of challenges to conventional wisdom in the study of architectural modernism. First of all, it challenges the accepted assumption that both the modern movement and the *Glashaus* are best understood in terms of a 'clean break' from the past. Clearly, this is not the case, since the thesis has demonstrated that the *Glashaus*' design drew upon the architecture featured in previous World Fairs, the Gothic tradition, and the glasshouses of the *Victoria regia*. This thesis thus makes a significant contribution to answering one of the pivotal remaining mysteries surrounding the *Glashaus* design—the unresolved and little-recognised relationship between horticultural glasshouses and modernist architecture.

By reintroducing Keppler within the narrative explaining the origins of the *Glashaus*, this thesis extends Gutschow's earlier contention that the *Glashaus* was a collaborative endeavour between Taut, Scheerbart and Behne. Before this study, the *Glashaus* was regarded as the product of an aesthetic collaboration between its visionary architect Taut and poet Scheerbart, and promoted through the prism of

Expressionism by the writer and theorist Behne. This study has altered that view of the *Glashaus* to include its commissioning client, Keppler. Furthermore, by placing the *Glashaus* within a context based in historical precedent and one that recognises the intention to market Luxfer products, the utopian associations of the *Glashaus* are reduced in favour of recognising the more prosaic and pragmatic immediate concerns that led to the commission in the first place.

This thesis significantly alters and enhances the historical understanding of the *Glashaus* by re-establishing the primary importance of the client–architect relationship and, in the process, it more comprehensively outlines the sources that Taut turned to for inspiration in the design of the *Glashaus*.

Yet, the outcome is that the *Glashaus* is still understood as a collaborative endeavour. The result of this thesis' argument is that the endeavour is now best understood as a relation of four different contributions, with Taut and Keppler being the primary contributors and Scheerbart and Behne being secondary.

By reinforcing the understanding of the *Glashaus* as a collaborative project primarily driven by the desire to promote building materials within a particular architectural vision, this study provides a concrete example that testifies to the original collaborative ideals of the *Werkbund*. The *Glashaus* can therefore be proposed as a *Qualität* object that was the achieved through the shared vision of a progressive client and an enlightened architect. Yet, by revealing how Taut freely interpreted the influence of Gothic and *Victoria regia* for the design of his *Glashaus*, this study also underscores Taut's opposing vision for the *Werkbund*; that is, it reinforces his stated opposition to Muthesius' proposal for *Typisierung* by revealing his counter-ideal that nonetheless maintains artistic individualism.

6.4 Parameters of the Study

The *Glashaus*, as a building, was only accessible for public viewing for a few short weeks in 1914. After which, it was closed due to the commencement of World War One and subsequently demolished. This is a limitation for a PhD study of Taut and the *Glashaus:* the inability to directly experience the particular building being scrutinized in this study. A second related difficulty is the inability to interview the architect, client and other people associated with the building commission and its first analyses.

Despite existing for such a short time, the building nonetheless became an important point of reference in the evolving accounts and histories of modernist architecture with various accounts emerging from that point in time to the present. Hence, a historical-interpretive investigation of the topic remains as relevant as ever because the role of the *Glashaus* is still being debated and new evidence as well as new interpretations are still being offered today. This study contributes to that still evolving interpretation.

As stated above, Banham argued that the *Glashaus* was both vastly dissimilar from and yet exceeded any of Taut's previous designs (Banham, 1959 p.87). Considering this statement and the findings of this research, a subsequent discussion that attempts to link Taut's sources of design inspiration in the *Glashaus* to his later work, deserves future analysis. The provisional connection of Ruskin to Taut is an area of this thesis that is likewise appropriate for future inquiry. Likewise, the translations of "Die Galoschen des Glucks" and the quotes concerning Taut having climbed Strasbourg Cathedral's spire, derive from the well-respected and trusted secondary-source of Iain Boyd Whyte. One future research task would be to seek to obtain the original letters written by Taut in order to verify all the translations provided.

While neither Taut nor Keppler left any written accounts that explicitly stated their motives and inspirations for the design of the *Glashaus*, this PhD study has examined all the relevant studies to date as well as the basis of their analyses. This research, however, uncovers additional sources of evidence that provide new insights into the development of the design that have not previously been fully examined. Therefore this research overcomes the barriers mentioned above and achieves new insights that contribute to this absorbing history.

6.5 Peer evaluation of research

The validity of the original contributions of this study have been verified through the publication of four double-blind, peer-reviewed conference papers and one journal article. The first, "Victoria regia's bequest to Modern Architecture"

(Nielsen, 2010), tested the proposition that the *Glashaus* had a connection with the *Victoria regia* lily and the glasshouses constructed for it. The second, “Deceit and Bruno Taut’s Glashaus” (Nielsen, 2011), probed the Expressionist labelling of the *Glashaus* by expanding on the arguments present in the first paper, while also arguing that the *Glashaus* had a connection to Strasbourg Cathedral. The third, “Client intentions and Bruno Taut’s Glashaus“ (Nielsen, 2012), exposed the important links that the *Glashaus* had with the *Deutsche Luxfer Prismen Syndikat* and the earlier iterations of its exhibition prototype. The fourth paper, “Nature’s muses in Bruno Taut’s Glashaus” (Nielsen & Kumarasuriyar, 2012), explained the connections that the *Glashaus* had to Taut’s writings, Gothic architecture and the *Victoria regia.* The final journal article, “The lily, client and measure of Bruno Taut’s Glashaus” summarised all of the key arguemnets made in this thesis (Nielsen & Kumarasuriyar, 2014). Furthermore, the arguments concerning the *Victoria regia* have been mentioned in *Victoria: The Seductress* (Anisko, 2013).

6.6 Conclusion

This study has established that many of the diverse motives and inspirations behind the design of the *Glashaus* can be traced back to its unique client–architect relationship. As its client, Keppler dictated a highly specific prototype for the design of the *Glashaus*. In turn, Taut, as the project’s architect, developed this prototype into the *Glashaus* by using the aesthetic and design precedents of the *Victoria regia* lily and the Gothic aesthetic. The result is an account that re-establishes some of Banham’s (1959) ‘prophetic ancestry’ of modern architecture by introducing yet unexplored personalities, myths, and symbols that were associated with the *Glashaus*.

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